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Love Canal Emergency Declaration
Area Habitability Study
Volume 5. Peer Review Summary
TRC (Technical Review Committee) Responses

CH2M Hill Southeast, Inc., Reston, VA

Prepared for

Environmental Protection Agency, New York

Jul 88

U.S. Department of Commerce
National Technical Information Service

PB88-249149

United States
Environmental Protection Agency

LOVE CANAL EMERGENCY DECLARATION AREA HABITABILITY STUDY

FINAL REPORT

VOLUME V

Peer Review Summary-- TRC Responses

TECHNICAL REVIEW COMMITTEE

U.S. Environmental Protection Agency Region II
U.S. Department of Health and Human Services / Centers for Disease Control
New York State Department of Health
New York State Department of Environmental Conservation

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Environmental studies were conducted to provide data that could be used by the Commissioner of Health for the State of New York in determining whether the Emergency Declaration Area surrounding the Love Canal hazardous waste site is habitable. The results of the studies are contained in Volumes II through IV of this series. These volumes (II through IV) were reviewed by a peer review panel of expert scientists. The scientists concluded that each of the three environmental studies was well planned and well executed. Volume V summarizes the peer review and gives additional information or clarifications as requested during the peer review. Volume V also provides additional supplemental statistical analyses requested by the peer reviewer panel.

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ICAIR, LIFE SYSTEMS, Inc., under separate EPA contract, organized the peer review effort and facilitated the peer review meeting. ICAIR prepared Sections 1.0 and 3.0 of this volume. Section 3.0 was concurred with by each peer review panel member. CH2M HILL prepared responses to the peer review panel's comments and managed the preparation of Volume V. CH2M HILL was assisted by its subcontractor firms. The specific technical contributions of these other organizations are noted in the Acknowledgements sections of Volumes II through IV.

Finally, the participation and dedication of the six expert scientists who served on the peer review panel is gratefully acknowledged.

LIST OF ABBREVIATIONS AND ACRONYMS

A-BHC	Alpha-hexachlorocyclohexane
ATSDR	Agency for Toxic Substances and Disease Registry
BHC	Hexachlorocyclohexane
B-BHC	Beta-hexachlorocyclohexane
BQC	Blind Quality Control
CB	Chlorobenzene
CC	Continuing Calibration
CLP	Superfund Contract Laboratory Program
CNP	2-chloronaphthalene
CT	Chlorotoluene
DBB	1,4-dibromobenzene
D-BHC	Delta-hexachlorocyclohexane
DCB	1,2-dichlorobenzene
DHHS/CDC	Department of Health and Human Services/Centers for Disease Control
DQO	Data Quality Objective
EDA	Emergency Declaration Area
EMSL-LV/LEMSCO	Environmental Monitoring Systems Laboratory-Las Vegas/Lockhead Engineering and Management Services Company
EPA	U.S. Environmental Protection Agency

FHB	Field Handling Blanks
FOIA	Freedom of Information Act
g	grams
G-BHC	Gamma-hexachlorocyclohexane
GC/MS	Gas Chromatograph/Mass Spectrometer
IC	Initial Calibration
IQR	Interquartile Range
IS	Internal Standard
IS5	Internal Standard No. 5 D-10 Pyrene
Kg	Kilogram
LCARA	Love Canal Area Revitalization Agency
LCIC	Love Canal Indicator Chemical
m^3	Cubic Meter
MHB	Method/Holding Blanks
MPC	Maximum Possible Concentration
MS	Matrix Spike
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NEIC	EPA National Enforcement Investigation Center
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORD	Office of Research and Development
OTA	Congressional Office of Technology Assessment

PC-AT	Personal Computer--AT
PC1	First Performance Check
PC2	Second Performance Check
PE	Performance Evaluation
ppb	parts per billion
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Relative Percent Difference
RRF	Relative Response Factor
RSD	Relative Standard Deviation
RT	Retention Time
SCS	Soil Conservation Service
SICP	Selected Ion Current Profile
SIM	Selected Ion Monitoring
S/N	Signal To Noise Ratio
SOP	Standard Operating Procedure
SSB	Shipping and Storage Blank
TAGA	Trace Atmospheric Gas Analyzer
TBBP	2,4,6-tribromobiphenyl
TCB	1,2,4-trichlorobenzene
TeBB	1,2,4,5-tetrabromobenzene

TeCB	1,2,3,4-tetrachlorobenzene
TRC	Technical Review Committee
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
%V	Percent Valley

Section 1.0
SUMMARY

The *Love Canal Emergency Declaration Area; Proposed Habitability Criteria* (NYSDOH and DHHS/CDC, 1986) was developed to assist the Love Canal TRC, a committee composed of senior-level officials from EPA, CDC/DHHS, NYSDOH, and NYSDEC, in conducting a study of the habitability of the Emergency Declaration Area (EDA). The criteria call for the performance of three environmental studies: (1) an assessment of the levels of Love Canal Indicator Chemicals (LCIC) in air in the EDA; (2) an assessment of the levels of LCICs in the soil of the EDA and selected comparison areas; and (3) an assessment of the levels of 2,3,7,8-tetrachlorodibenzeno-p-dioxin (TCDD) in the soil of the EDA. These studies have been completed, and the results are presented in Volumes II, III, and IV, (CH2M HILL, 1988a, b, and c) respectively, of this series.

Under the direction of the TRC, a peer review panel was convened to review the implementation of the three environmental studies. This volume reports on the findings of the peer review and provides the responses to that peer review. The objectives of the peer review were to determine whether the studies were properly designed and properly implemented, and whether the resulting data are reliable and appropriately presented. The peer review panel consisted of six expert scientists: an air chemist, a soil scientist, a civil engineer, an epidemiologist, and two statisticians.

Each peer reviewer prepared preliminary written comments on Volumes II through IV. The preliminary comments were supplied to the other peer reviewers, to the TRC, and to the public. Responses to these comments were submitted in the form of draft technical memoranda to the peer reviewers and the public prior to the peer review meeting. (The contents of the technical memoranda are included in this volume.)

The peer review meeting was held in Niagara Falls, New York, on June 20 and 21, 1988. The peer reviewers discussed their comments and concerns with each other, the TRC, and with the scientists who performed the studies. Members of the public were also given the opportunity to ask questions and make comments. Based on these discussions, the peer review panel reached the following conclusions:

- Each of the three environmental studies was well planned and well executed.

- There was a high degree of data quality control, and the data from each study are appropriate for making a determination on habitability.

- The statistical analyses of the data from the soil assessment for indicator chemicals, as presented in Volume III, are appropriate for making a determination on habitability.

The peer reviewers identified areas in which additional information or clarification would be useful and recommended that these topics be addressed in this final report. The additional information and clarification is contained in Sections 4.0 through 6.0 of this volume. In addition, the peer reviewers and the TRC requested additional supplemental statistical analyses (i. e., analyses that went beyond the study plan) that they felt would be useful in the habitability decision. The bulk of the appendices to this volume are dedicated to these supplemental analyses.

Upon acceptance of this volume, the TRC will transmit the five-volume habitability report to the Commissioner of Health for the State of New York for use in a determination of the habitability of the EDA.

Section 2.0
INTRODUCTION

This is Volume V of a five-volume series. Volume I (ICAIR and CH2M HILL, 1988) provides an introduction to the Love Canal EDA Habitability Study and documents the decision-making and history during its development; Volume II reports on the air assessment for indicator chemicals; Volume III reports on the soil assessment for indicator chemicals; and Volume IV reports on the soil assessment for 2,3,7,8-TCDD. Volume V summarizes both the peer review comments of Volumes II, III, and IV and the responses to those comments.

This section gives a brief background of the EDA and the habitability study. Section 3.0 summarizes the discussion, conclusions, and recommendations of the peer review panel, which were reviewed and approved by each panel member. Sections 4.0, 5.0, and 6.0 provide the responses to the peer review comments concerning the air assessment for indicator chemicals, the soil assessment for indicator chemicals, and the soil assessment for 2,3,7,8-TCDD, respectively.

Several appendices contain more detailed technical information and analyses to support the responses given in Sections 4.0, 5.0, and 6.0.

2.1 BACKGROUND

The EDA is a residential area surrounding the Love Canal chemical waste site in Niagara Falls, New York. The majority of the EDA residents vacated the area because of concern over the potential health effects of chemicals from the site. The site has undergone extensive remediation. (An extensive history of the Love Canal site and the surrounding EDA is presented in Volume I.)

The Love Canal TRC, composed of representatives from the EPA, DHHS/CDC, NYSDOH, and NYSDEC, was established to coordinate and oversee the remedial program and habitability study at the Love Canal. The habitability study was designed to enable the Commissioner of Health for the State of New York to determine whether the EDA is now suitable for human habitation.

The following studies and activities have taken place:

- Development of the habitability criteria
- Peer review of the habitability criteria
- Pilot study of the proposed soil and air assessments for indicator chemicals
- Peer review of the pilot study
- Soil and air assessments for indicator chemicals and a soil assessment for 2,3,7,8-TCDD
- Peer review of the assessments

This volume documents and responds to the peer review of the three environmental assessments.

Figures 2-1 and 2-2 are included for the convenience of the reader. Figure 2-1 shows the EDA sampling area and neighborhood boundaries, and Figure 2-2 shows the relative location of the EDA and the comparison areas used in the study.

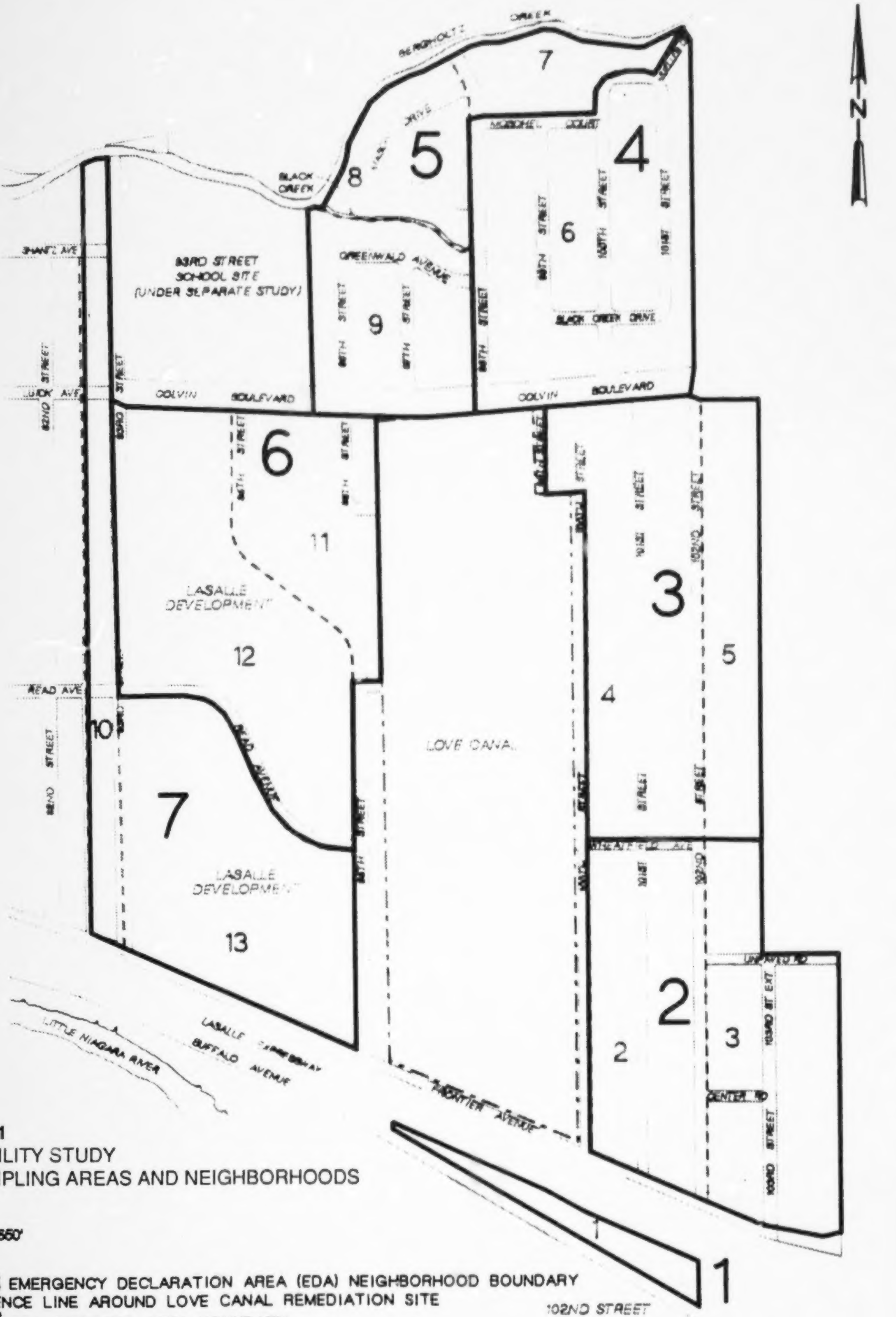
N
BERGHOLTZ CREEK
7
5
4
8
BLACK CREEK
MOSOVEL COURT
6
99TH STREET
100TH STREET
101ST STREET
BLACK CREEK DRIVE
GREENWALD AVENUE
9
96TH STREET
97TH STREET
98TH STREET
93RD STREET SCHOOL SITE (UNDER SEPARATE STUDY)
SHANTZ AVE
92ND STREET
93RD STREET
COLVIN BOULEVARD
COLVIN BOULEVARD
6
95TH STREET
96TH STREET
11
LASALLE DEVELOPMENT
12
3
101ST STREET
102ND STREET
99TH STREET
5
4
READ AVE
10
92ND STREET
READ AVENUE
7
97TH STREET
LOVE CANAL
LASALLE DEVELOPMENT
13
WHEATFIELD AVE
101ST
102ND
2
2
3
UNPAVED RD
103RD ST EXT
CENTER RD
103RD STREET
LITTLE NIAGARA RIVER
LASALLE EXPRESSWAY
BUFFALO AVENUE
FRONTIER AVENUE
1
102ND STREET LANDFILL

Figure 2-1
HABITABILITY STUDY
EDA SAMPLING AREAS AND NEIGHBORHOODS

SCALE: 1"=650'

LEGEND

- - - 13 EMERGENCY DECLARATION AREA (EDA) NEIGHBORHOOD BOUNDARY
— - — FENCE LINE AROUND LOVE CANAL REMEDIATION SITE
—7 EDA SAMPLING AREA BOUNDARY

SOURCE: NEIGHBORHOOD BOUNDARIES ADAPTED FROM THE PROPOSED HABITABILITY CRITERIA DOCUMENT (NYSDOH AND DHHS/CDC, 1986).

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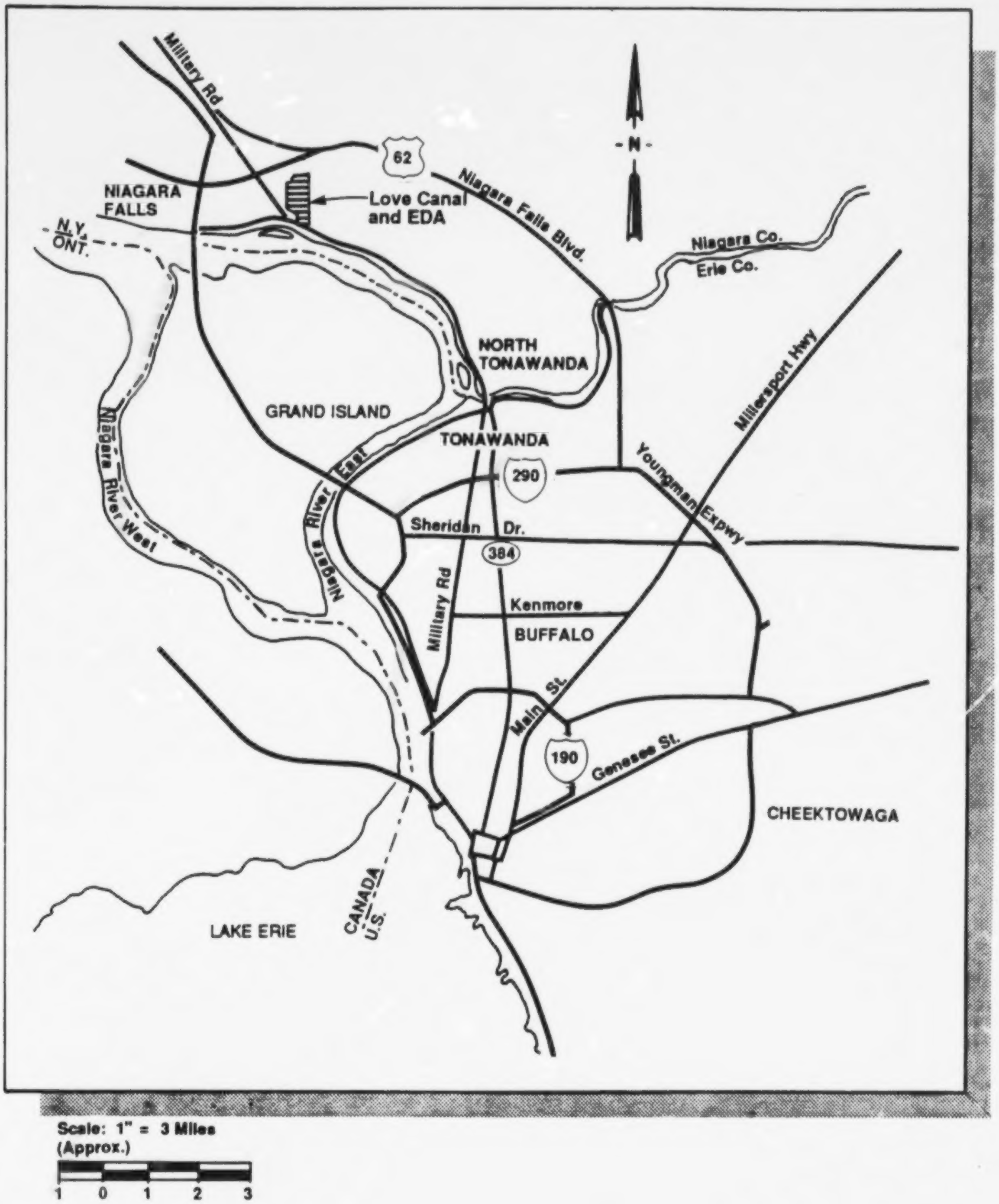
Military Rd
62
Niagara Falls Blvd.
NIAGARA FALLS
Love Canal and EDA
N.Y.
ONT.
N
Niagara Co.
Erie Co.
NORTH TONAWANDA
GRAND ISLAND
TONAWANDA
Millersport Hwy
Niagara River West
Niagara River East
290
Youngman Expwy
Sheridan Dr.
384
Kenmore
BUFFALO
Military Rd
Main St.
190
Genesee St.
CHEEKTOWAGA
LAKE ERIE
CANADA
U.S.
Scale: 1" = 3 Miles
(Approx.)
1
0
1
2
3

Figure 2-2
HABITABILITY STUDY
LOCATION OF EDA AND COMPARISON AREAS
IN NEW YORK STATE

Section 3.0
PEER REVIEW MEETING SUMMARY

The objective of this chapter is to summarize the final conclusions and recommendations of the peer review panel. This summary has been reviewed and approved by each panel member. The panel's findings are presented for the air assessment for indicator chemicals, the soil assessment for indicator chemicals, and the soil assessment for 2,3,7,8-TCDD. An overall evaluation of the suitability of the data for a decision on habitability is also presented.

3.1 AIR ASSESSMENT—INDICATOR CHEMICALS

3.1.1 Consensus Evaluation

The peer review panel unanimously agreed that the air assessment for LCICs (CH2M HILL, 1988a) was adequately designed and implemented and that the data obtained are reliable.

3.1.2 Technical Issues

Technical questions or concerns that were raised by the peer reviewers prior to the peer review meeting were summarized and responded to by CH2M HILL in technical memoranda provided to the peer reviewers. Comment summaries and responses are presented in Section 4.0 of this volume.

3.1.3 Recommendations

The peer review panel identified several areas where additional information or clarification would be useful and recommended that these be addressed. These recommendations are summarized below.

- Provide a more thorough description of how the detection limit for the Trace Atmospheric Gas Analyzer (TAGA) was calculated.

- Provide information on how the sensitivity of the TAGA for the LCICs depended on humidity.

- Provide more detailed information on rainfall levels during the sampling period, with special reference to the levels of precipitation that occurred during 1975 and 1976, when chemical migration from the Love Canal was most obvious.

- Provide a more thorough description of the significance and the limitations of the data. This would include discussion of the following topics:

  - Concentrations of contaminants in air are highly variable in time and space, and even thorough studies such as this one cannot provide complete assurance that all occasions of elevated contaminant levels have been detected.

  - Heating a home creates a pressure gradient that tends to increase infiltration of soil gas into the house. Since most of the EDA residences were unoccupied and it was not practical to heat them, this may have decreased the ability to detect LCICs in indoor air.

  - The finding that one home out of 562 in the EDA had measurable levels of air LCICs should be viewed in the perspective that, in the pilot study, 1 home out of 31 in the control area also had measurable levels.

  - It is not inconsistent to observe measurable levels of LCICs in soil but not in air.

In addition, even though the air study identified only one home in the EDA with measurable levels of indicator chemicals, if rehabitation occurs and if individuals continue to have concerns, it may be desirable to make information available on home ventilation devices that have been used elsewhere for the control of radon gas. These devices might also be used for the control of possible soil-gas accumulation in homes.

3.2 SOIL ASSESSMENT—INDICATOR CHEMICALS

3.2.1 Consensus Evaluation

The peer review panel unanimously agreed that the assessment for soil indicator chemicals (CH2M HILL, 1988b) was particularly well planned and well performed. In addition, the panel unanimously agreed that the statistical analyses of the data were appropriate and correct, and are suitable for making a determination on habitability.

3.2.2 Technical Issues

Technical questions or concerns that were raised by the peer reviewers prior to the peer review meeting were summarized and responded to by CH2M HILL in technical memoranda provided to the peer reviewers. These summaries and responses to comments are presented in Section 5.0 of this volume.

3.2.3 Recommendations

The peer review panel identified several areas where additional information or clarification would be useful, and recommended that these be addressed. These recommendations are summarized below.

- Although the statistical analyses of the data reported in Volume III are the most appropriate and are adequate for a habitability decision, several additional statistical analyses or summaries may be useful. These include:
    - Analyses fitting parametric distributions (e.g., lognormal mixture) and comparison of various percentile values (e.g., 50 percent, 90 percent, 95 percent)
    - Additional explanation regarding the purpose and meaning of the various analyses of robustness (sensitivity)
    - Summarization of the results of the existing statistical analyses, organized by sampling area

  - Additional sensitivity or robustness analyses for 1,2,4-trichlorobenzene (TCB), treating all values below 2.0 parts per billion (ppb) as non-detects

- Provide a more detailed explanation of the procedure used to select Census Tracts 221 and 225 as the comparison areas in Niagara Falls.

- Provide additional description and explanation regarding the absence of blank correction in the data reported, with special attention to the distinction between laboratory background and actual soil sample data.

- Provide additional explanation as to why some samples were "flagged," and the steps taken to ensure that this did not introduce a bias.

- Review available hydrogeological and meteorological data to determine whether any likely transport mechanism from the Love Canal can be identified to account for the elevated levels of soil LCICs observed in Sampling Areas 1, 2, and 3. Identification of such a mechanism would support the hypothesis that the observed differences are due to the Love Canal.

3.3 SOIL ASSESSMENT—2,3,7,8-TCDD

3.3.1 Consensus Evaluation

The peer review panel unanimously agreed that the soil assessment for 2,3,7,8-TCDD (CH2M HILL, 1988c) was adequately designed and implemented and that the data are reliable.

3.3.2 Technical Issues

Technical questions or concerns that were raised by the peer reviewers prior to the peer review meeting were summarized and responded to by CH2M HILL in technical memoranda provided to the peer reviewers. These comment summaries and responses are presented in Section 6.0 of this volume.

3.3.3 Recommendations

The peer review panel identified several areas where additional information or clarification would be useful, and recommended that these be addressed. These recommendations are summarized below.

- Provide an overview of the data quality assurance activities associated with the soil dioxin study, with appropriate cross-references to the relevant portions of the Quality Assurance Project Plan (QAPP) (CH2M HILL, 1986 and 1987e).

- Provide the following additional information that might be useful in interpreting the significance and the limitations imposed by having sampled surface soil only.

    - The possible occurrence of "hot spots" other than the one detected, and the limitations imposed by having sampled surface soil only

    - The chance of exposure to dioxin-contaminated soil as a function of the area and depth of the contaminated soil

    - The chronic exposure conditions assumed by the CDC in the derivation of the 1.0-ppb level of concern, as these relate to the types of exposures that might be expected to occur in the EDA

    - The relative magnitude of the potential health risks associated with exposures to small and/or subsurface areas of dioxin contamination, expressed in language readily understandable by the average citizen

- Provide a summary of dioxin soil measurements as a function of the time of year when samples were taken, to ensure that changes in the sampling schedule did not introduce a significant source of variation.

3.4 SUMMARY

A peer review panel of six expert scientists reviewed Volumes II, III, and IV of the Love Canal Habitability Study Final Reports, along with associated supporting documentation. The panel members are listed in Table 3-1. The panel unanimously agreed that each of the component parts of the habitability study was well planned, well executed, and had a high level of data quality assurance, and that the resulting data are of high quality and are appropriate for making a determination on habitability. In addition, the statistical analyses of indicator chemical levels in soil as reported in Volume III and supporting documents are appropriate for the purposes of making a habitability decision. The panel identified a number of areas where additional information or clarification would be useful, and recommended that these be addressed.

Table 3-1
PEER REVIEW PANEL ON LOVE CANAL HABITABILITY STUDY FINAL REPORTS

Dr. Janick F. Artiola
Assistant Research Scientist
Department of Soil and Water Science
University of Arizona
Tuscon, Arizona

Dr. Randall Charbeneau
Associate Professor of Civil Engineering
University of Texas
Austin, Texas

Dr. Joan Daisey
Staff Scientist in Air Chemistry
Lawrence Berkeley Laboratory
Berkeley, California

Dr. David Schoenfeld
Director of the Biostatistics Center
Massachusetts General Hospital and
Harvard University
Boston, Massachusetts

Dr. Carl Shy
Professor of Epidemiology
University of North Carolina
Chapel Hill, North Carolina

Dr. Michael R. Stoline
Professor of Statistics
Western Michigan University
Kalamazoo, Michigan

Section 4.0

RESPONSES TO COMMENTS ON THE AIR ASSESSMENT FOR INDICATOR CHEMICALS

This section briefly describes the peer review comments on Volume II, *Air Assessment--Indicator Chemicals* (CH2M HILL, 1988a), and it gives the responses to those comments. Both written preliminary peer review comments and verbal peer review comments made during the peer review meeting are addressed in this section. The peer review comments have been organized under the categories of "Design," "Methods," "Results," and "Other." Each comment is paraphrased, the peer reviewer making the comment is referenced, and the response to the comment is given. Where lengthy responses are required, the response is summarized in this section, while the full response is provided in an appendix.

4.1 DESIGN

4.1.1 Sampling Strategy

COMMENT: Concentrations of contaminants in air are highly variable, and even thorough studies such as this one cannot provide complete assurance that all potential occasions of detectable contaminant levels have been identified. (Dr. Joan Daisey--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: The air assessment was designed to provide the most thorough investigation of the presence of LCICs in ambient and indoor air as was possible, given time and other practical constraints. Sampling phases during a 5-month study period and sampling times staggered within each phase were incorporated as part of the design to best assess variation of diurnal and seasonal parameters that could possibly affect the presence of LCICs in homes.

It was not practical to sample under all conditions that may potentially cause fluctuations in LCIC concentrations. Because concentrations of contaminants in air are variable, this study, as would any study, falls short of offering complete assurance that all potential occasions of detectable contaminant levels have been identified. However, the study was specifically designed to include a wide variety of conditions that could possibly influence the concentration of air LCICs in the homes of the EDA.

COMMENT: Clarify how sampling was conducted during a 24-hour period if the instrument could be operated only 15 hours per day. (Dr. Joan Daisey--Written Preliminary Comments, p. 3.)

RESPONSE: Daily sampling was performed in shifts averaging approximately 12 hours. The starting times of these shifts were varied so that sampling of unoccupied homes was performed throughout all hours of the day and night during a given phase to allow observation of any detectable diurnal variation of LCICs. Sampling of occupied homes, however, was conducted only between the hours of 7:00 a.m. and 9:00 p.m. Table 5-1 on page 5-7 of the air assessment QAPP (CH2M HILL, 1987a) depicts an example of this sampling strategy.

4.1.2 Heating of Unoccupied Homes

COMMENTS: Document whether heat was on or off in unoccupied homes. If the unoccupied homes were not heated, potential soil-gas transport into the homes could be missed. (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

Heating a home creates a pressure gradient that tends to increase infiltration of soil gas into the house. Since most of the EDA residences were unoccupied and it was not practical to heat them, this may have decreased the ability to detect LCICs in indoor air. (Dr. Joan Daisey--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: Heating of unoccupied homes during the sampling effort was not practical because of the sampling time frame and the extent of disrepair of the heating devices within many of the homes. However, no evidence of pressure-driven flow influencing LCIC concentrations was indicated during sampling of heated, occupied homes. During Phase 4--the coldest sampling period--23 occupied heated homes distributed throughout the EDA were sampled, and no LCICs were detected.

4.1.3 Rainfall and Ground Water Levels

COMMENTS: Discuss how varying rainfall and ground water levels are incorporated into the study design. (Dr. Michael Stoline--Written Preliminary Comments, p. 9.)

The design makes it difficult to assess the influence of rainfall and/or ground water levels on LCIC levels. Also, it is difficult to assess the influences of rainfall and ground water levels outside the range encountered during sampling, within the context of this design. (Dr. Michael Stoline--Written Preliminary Comments, p. 2.)

No evidence is presented to suggest that the possible influence of ground water levels is properly accounted for or tested. (Dr. Randall Charbeneau--Written Preliminary Comments, p. 5.)

RESPONSE: Representative meteorological parameters, including hourly wind and precipitation, are recorded at the nearby Niagara Falls International Airport. Ground water levels near the EDA are recorded by the NYSDEC. The influence of these parameters on the presence of LCICs in the EDA air is not known. Rainfall and ground water levels were not specifically assessed in Volume II because LCICs were virtually undetected throughout the 5-month assessment. Had there been a higher frequency of LCICs detected during the assessment, an evaluation of these and other parameters would have been conducted. (In response to peer reviewer comments, ground water and rainfall level variability during the study was compared to historical variability—see Section 4.3.4 below.)

4.1.4 Design Modifications

COMMENT: Discuss any other changes or modifications that may have been implemented during the study. (Dr. Janick Artiola--Written Preliminary Comments, p. 3.)

RESPONSE: Changes and modifications implemented during the study include modifications to TAGA analytical procedures, changes in the phase-specific documentation, clarification of ambiguities, correction of errors in original TAGA operating and data reporting criteria, and additional documentation and TAGA operational procedures. Refer to Appendix A containing the memorandum from the EPA Environmental Response Branch, dated April 15, 1988, for additional details.

4.2 METHODS

4.2.1 TAGA Performance Criteria

COMMENTS: Origins of TAGA performance criteria (items 1 through 6 in Table 4-1 of the QAPP, CH2M HILL, 1987a) are not properly referenced or justified. (Dr. Janick Artiola--Written Preliminary Comments, p. 2.)

Provide a more thorough description of how the detection limit for the TAGA was calculated. (Dr. David Schoenfeld--Peer Review Meeting Comments, June 20, 1988.)

The QAPP (CH2M HILL, 1987a) lacks a calculation of the actual detection limit as opposed to the nominal detection limit. (Dr. David Schoenfeld--Written Preliminary Comments, pp. 2-5.)

A perspective is needed on the selected detection limit objective of 4.0 ppb. Is this concentration lower than that expected in ambient air if Love Canal were the source of the chemicals (i.e., is the detection limit objective of 4.0 ppb appropriate with respect to the overall study goal)? Were the levels detected prior to remediation significantly higher than the objective for detection limits (i.e., was the selection of the detection limit objective based on historical data)? Is there any basis for human health concern if levels of LCICs below the detection limits were to exist in the EDA (i.e., in retrospect, could there be a health risk even though LCICs were not--for the most part--detected)? (Dr. Carl Shy--Written Preliminary Comments, p. 6.)

Provide information on how the sensitivity of the TAGA for the LCICs depended on humidity. (Dr. Ed Horn (NYSDOH)--Peer Review Meeting Comments, June 20, 1988.)

In Appendix A of the QAPP (CH2M HILL, 1987a) a factor of two is missing from equation 2 in Section 4.3.3, p. 4-12 and E_C is not defined on pp. vii-viii. (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

RESPONSE: TAGA performance criteria were based on achievable instrument limits and were derived from several months of method development. The detection limit issue was addressed by two different approaches: statistical models and review of detection limit verifications and instrument calibrations.

Two different statistical models were used to attempt to predict actual detection limits with known confidence intervals. Because of the TAGA's analytic complexities and the need for these statistical models to make assumptions simplifying the analytic procedure, the models were unable to accurately predict reasonable detection limits.

A verification of detection limits was performed on a daily basis during the assessment. A total of 44 verifications were performed and in all of them, the LCICs were successfully detected. The TAGA was calibrated using known LCIC concentrations of approximately 2.0 ppb and 4.0 ppb prior to sampling each of the 562 different homes in the EDA. For all but a few of those known concentrations very near the nominal detection limit (<0.5 ppb), these concentrations met all of the detection limit criteria.

In controlled experiments performed at Edison, the maximum decrease in TAGA sensitivity under maximum shifts of relative humidity (dry zero air to near-saturation) never exceeded a factor of two. The TAGA's sensitivity was always highest with zero air (no humidity) and suffered the largest relative drop when the sample air was initially humidified. Therefore, the effects of humidity changes on the detection limits for the EDA houses should always be less than a factor of two because there must always be some humidity in the ambient and indoor air.

For a detailed discussion of these issues and those raised by Dr. Ed Horn of the NYSDOH, refer to Appendix B containing the memorandum from the EPA Environmental Response Branch, dated June 13, 1988 (Revised July 7, 1988).

4.2.2 TAGA Operation

COMMENTS: Was the TAGA logbook audited? (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

It is hard to discern the instrument startup and end-of-day calibration procedures from those implemented prior to sampling each house. (Dr. Janick Artiola--Written Preliminary Comments, p. 2.)

RESPONSE: Auditing of the TAGA logbook was performed by personnel from Northrop Services under contract with EPA's Office of Research and Development (ORD). Instrument startup and end-of-day procedures have been more clearly defined. Refer to Appendix B, which contains the memorandum from the EPA Environmental Response Branch, dated June 13, 1988 (Revised July 7, 1988).

COMMENTS: What air was used for calibration? If outdoor air was used and LCICs were present, then aren't I_0 and the lower limit of detection higher than reported? (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

The procedure used for calibrating the TAGA assumes that the ambient air is uncontaminated. If the ambient air was contaminated, another method was used. This procedure was to be a revision to the QAPP (CH2M HILL, 1987a), but I did not find it in the revisions. (Dr. David Schoenfeld--Written Preliminary Comments, p. 5.)

RESPONSE: The TAGA is calibrated using ambient air. If ambient air were contaminated, reported detection limits would be biased high and corrective measures would be taken. Refer to Appendices B and C, which contain the memoranda from the EPA Environmental Response Branch, dated May 19 and June 13, 1988, for additional details.

COMMENT: Discuss that the sampling line was not heated during Phases 2, 3, and 4 of the sampling. (Dr. Joan Daisey--Written Preliminary Comments, p. 5.)

RESPONSE: Efficient transport of sample air through an unheated transfer line was demonstrated during the continuing method development that was conducted between Phases 1 and 2 of the study. Therefore, the more flexible and lighter-weight unheated line was used in Phases 2, 3, and 4. Refer to Appendix A, which contains the memorandum from the EPA Environmental Response Branch, dated April 15, 1988, for additional information.

4.2.3 Quality Assurance

COMMENT: Difficulty with the first blind canisters should be discussed, specifically the time frame in which this occurred and whether it compromised any of the actual sampling. (Dr. Joan Daisey--Written Preliminary Comments, p. 1.)

RESPONSE: Because non-field-proven state-of-the-art methods lead to initial uncertainties in the concentration of LCICs in performance evaluation, 6-liter-canister, standard gas cylinders were substituted for blind canisters in the first phases. External checks of the TAGA accuracy were performed by the

EPA's ORD contractor, Northrop Services, with one blind 16-liter canister audit sample per phase. During all four phases, TAGA results were within the accuracy criteria. Data quality was not compromised as a result of this substitution. Refer to Appendix A, which contains the memorandum from the EPA Environmental Response Branch, dated April 15, 1988, for additional information.

COMMENT: Clarify how it was determined that there were no interferences for the selected ions. (Dr. Joan Daisey--Written Preliminary Comments, p. 3.)

RESPONSE: Method development involved the search for interferent compounds; none was found. In addition, interferences, if they occurred, would bias sampling results high and have the potential to produce false positives. Only one LCIC detect was observed during the study, and this detect was confirmed using a canister sample taken onsite. Refer to Appendix B, which contains the memorandum from the EPA Environmental Response Branch, dated June 13, 1988, for additional information.

4.3 RESULTS

4.3.1 Sampling Activity

COMMENT: An additional figure should be added showing the locations of each of the homes that could not be sampled. (Dr. Janick Artiola--Written Preliminary Comments, p. 3.)

RESPONSE: Figure 4-1 is a composite of Figures 6-1 through 6-4 of Volume II; this figure identifies all homes sampled and not sampled during the study.

COMMENT: What were the reasons for homeowner refusal? (Dr. Michael Stoline--Written Preliminary Comments, pp. 1 and 6.)

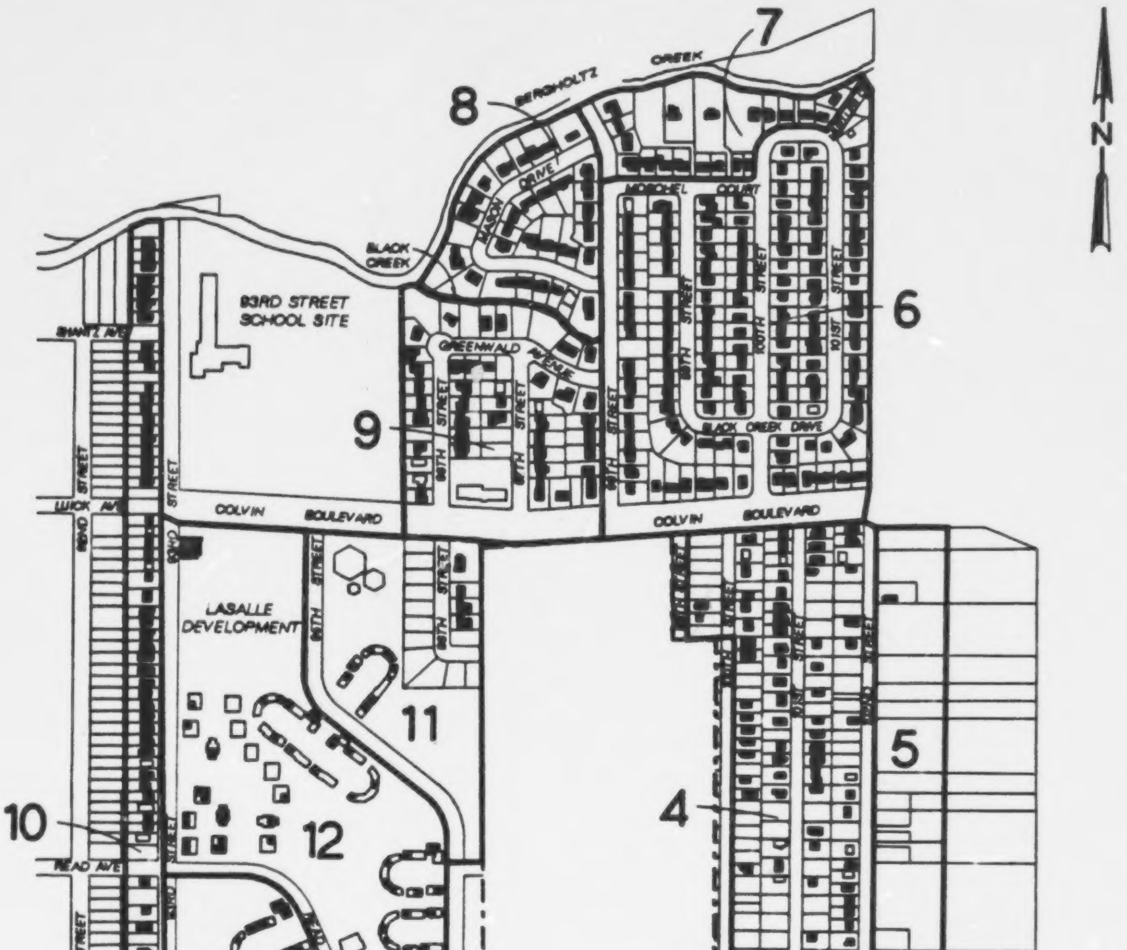
N
7
8
BERGHOLTZ
CREEK
MASON DRIVE
MOSCHEL COURT
BLACK CREEK
93RD STREET SCHOOL SITE
GREENWALD AVENUE
99TH STREET
100TH STREET
101ST STREET
6
9
98TH STREET
97TH STREET
96TH STREET
BLACK CREEK DRIVE
SHANTZ AVE
LUICK AVE
92ND STREET
93RD STREET
COLVIN BOULEVARD
LASALLE DEVELOPMENT
96TH STREET
95TH STREET
11
5
4
10
12
READ AVE
LOVE CANAL REMEDIATION SITE
WHEATFIELD AVE
101ST STREET
102ND STREET
LASALLE DEVELOPMENT
13
97TH STREET
UNDERPASS RD
102ND ST EXT
2
LITTLE NIAGARA RIVER
LASALLE EXPRESSWAY
BUFFALO AVENUE
FRONTIER AVENUE
CENTER RD
103RD STREET
3
1

Figure 4-1
AIR ASSESSMENT--INDICATOR CHEMICALS
DISTRIBUTION OF HOMES SAMPLED
PHASES 1–4
SCALE: 1"=650'

LEGEND
━━ EDA NEIGHBORHOOD BOUNDARIES (NUMBERED 1-13)
— · — FENCE LINE AROUND LOVE CANAL REMEDIATION SITE
▬ HOMES SAMPLED APPEAR SHADED ON FIGURE

SOURCE: NEIGHBORHOOD BOUNDARIES ADAPTED FROM THE PROPOSED HABITABILITY CRITERIA DOCUMENT (NYSDOH AND DHHS/CDC, 1986).

RESPONSE: The reasons for homeowner refusal for each of the environmental assessment programs have been compiled by the NYSDOH and are contained in Appendix D.

4.3.2 Analytic Results

COMMENTS: I suggest that 95 percent confidence intervals be given on the detection limits. (Dr. Joan Daisey--Written Preliminary Comments, p. 6.)

The range of quantifiable detection limits is needed. (Dr. Janick Artiola--Written Preliminary Comments, pp. 6-7.)

RESPONSE: Detection limits computed for each house analyzed have been summarized, and a frequency distribution of those limits has been developed for each sampling phase. For all phases, 95 percent of the detection limits were below 1.3 ppb for chlorobenzene (CB) and 1.7 ppb for chlorotoluene (CT). Refer to Appendices B and C, which contain the memoranda from the EPA Environmental Response Branch, dated May 19 and June 13, 1988, for more information on the detection limits.

4.3.3 Discussion of Detects

COMMENT: Wind direction before, during, and after the sampling period should be checked for the CT detect situation. The LCIC might have entered the house by infiltration if the wind were blowing from a source, and if the wind changed by the time the sampling team arrived, the outdoor air would not show detectable levels. However, because the air exchange rates of houses are slow, typically 0.5 to 1.0 per hour, the house would still contain the accumulated LCIC. (Dr. Joan Daisey--Written Preliminary Comments, p. 7.)

RESPONSE: Screening and investigative sampling for the home where CT was detected took place over a 6-1/2-hour period, 7:30 a.m. to 2:00 p.m. Based on wind data collected at the Niagara Falls International Airport, a shift in wind direction (west-southwest to north-northeast) occurred at 9:30 a.m. Before this house was sampled, winds were steady from the west-southwest since 5:00 p.m. the previous day. In addition, ambient air was sampled 1 hour and 1/2 hour before the detect at a residence on the same street approximately 500 feet from the home in which CT was detected. Ambient air near the home with the detect was sampled just before the sampling team entered for indoor sampling. CT was detected on the main floor of the home throughout this period. While ambient air was sampled often during this time frame, LCICs were not detected in any ambient air samples before or during the investigation.

CT was detected again at the same residence 7 days later, while it had not been detected in any other home in the interim. The probability of transient plume infiltration only in this home during the assessment period is remote.

During the first sampling of this home in Phase 2, CT was detected on the home's main floor only. During the second sampling of this home, 7 days later in Phase 2, CT was detected both on the main floor and in the basement; levels of CT detected in the basement, however, were consistently lower than those detected on the main floor. Detection limits during this second sampling of Phase 2 were approximately one-half those during the initial sampling.

COMMENTS: The source of CT could have been subsurface contamination, contrary to what is implied in Volume II. A possible source is contaminated Love Canal fill soil. The case made for an outside air emission source is questionable based on the fact that no CT was detected in ambient air; on the other hand, CT emissions from industrial processes are not uncommon. (Dr. Janick Artiola--Written Preliminary Comments, pp. 4-5.)

Soil-gas transfer is a possibility. (Dr. Joan Daisey--Written Preliminary Comments, p. 6.)

RESPONSE: Fill dirt from the Love Canal is a possible mechanism of contamination. However, if fill dirt was present at the residence at which CT was detected, it had been there for many years. CT was detected only during Phase 2 of this assessment, although the same home was sampled again in Phases 3 and 4. In addition, detected levels of CT were lower during the second sampling of the home in Phase 2.

COMMENT: Is the detection of one LCIC in one home an isolated case of contamination or a random event? (Dr. Janick Artiola--Written Preliminary Comments, p. 6.)

RESPONSE: The fact that CT was detected twice in the same home 7 days apart and that no LCICs were detected in any other home or in ambient air during the assessment suggests that this detection is an isolated case rather than a random event.

4.3.4 Variation of Potentially Influencing Parameters

COMMENT: It might be appropriate to look at the ground water monitoring data to see if a range of ground water levels was encountered during the sampling periods. (Dr. Randall Charbeneau--Written Preliminary Comments, p. 5.)

RESPONSE: To evaluate the influence of local ground water levels on the results of the air monitoring study, data from relatively shallow overburden wells located outside the capped portion of the EDA were reviewed. Data from these wells best describe the local water-table elevation in the area that is not directly influenced by the hydraulic properties of the cap.

Only a limited amount of data was readily accessible. Data on near-surface ground water before 1980 are particularly limited, with less than 20 overburden wells investigated up to that time. In contrast, several studies have been conducted since 1980 that, combined, have involved approximately 1,000 samples of ground water, and a correspondingly large number of water-level measurements.

No data have been found that constitute a long-term historical record of local near-surface ground water at a single location. Consequently, it is not possible to identify continuous trends in water levels beginning from the time when the waste problem was first identified. Over the last few years, however, the NYSDEC has participated in water-level monitoring programs for some of the wells within the EDA. As a result, local water-level data are available for the period in which the air monitoring study was conducted, as well as for various times before the study.

Ground water-level data from selected overburden wells (1151D, 1154D, and 1183D) are shown in Table 4-1. Wells 1151D and 1154D are located at the southern end of the Canal near the LaSalle Expressway, and well 1183D is situated at the northern end, off Colvin Boulevard (Figure 4-2). The data indicate that very little variation occurred in water-table elevations during the time that the air study was conducted (mid-July to mid-December 1987). In fact, ground water levels in these wells have typically varied less than 1 foot since the wells were installed in 1986.

Information on near-surface ground water before 1986 must come from other overburden wells. Well 3151 is near wells 1151D and 1154D, and well 5115 is close to well 1183D (Figure 4-2). In 1980, the ground water elevation in wells 3151 and 5115 was 566.75 feet and 563.00 feet above mean sea level, respectively. These values are approximately 3 feet lower than the lowest water level reported for the wells listed in Table 4-1.

COMMENTS: The study was conducted during a 5-month period and may not be fully representative of the full range of meteorological conditions in this area. Appropriate qualifying statements should be included in the report. (Dr. Joan Daisey--Written Preliminary Comments, p. 6.)

Uncertainties remain with respect to the effects of seasonal variations (i.e., meteorological, temperature gradient indoor to outdoor, others). (Dr. Joan Daisey--Written Preliminary Comments, p. 8.)

Table 4-1

WATER LEVEL ELEVATIONS IN SELECTED OVERBURDEN WELLS

(feet above mean sea level)

Date		Well No.		
		1151D	1154D	1183D
1986	4-29	—	569.72	567.52
	5-13	—	569.12	567.56
	6-4	—	570.05	568.27
	7-30	—	570.31	568.09
	8-26	—	568.36	566.67
	10-1	—	569.11	567.19
	10-30	—	570.41	567.00
	12-5	570.72	570.11	566.93
	12-29	571.14	—	567.01
1987	1-29	570.21	—	567.55
	2-24	570.12	—	567.00
	3-25	569.93	569.73	567.57
	4-30	570.16	569.60	567.45
	5-28	569.66	569.31	569.46
	6-26	569.56	—	567.46
	7-30	569.36	568.78	567.52
	8-27	569.26	568.85	567.47
	9-23	570.80	568.91	567.51
	10-29	570.36	569.44	567.52
	12-22	570.96	—	567.45
1988	3-15	570.54	569.52	567.45

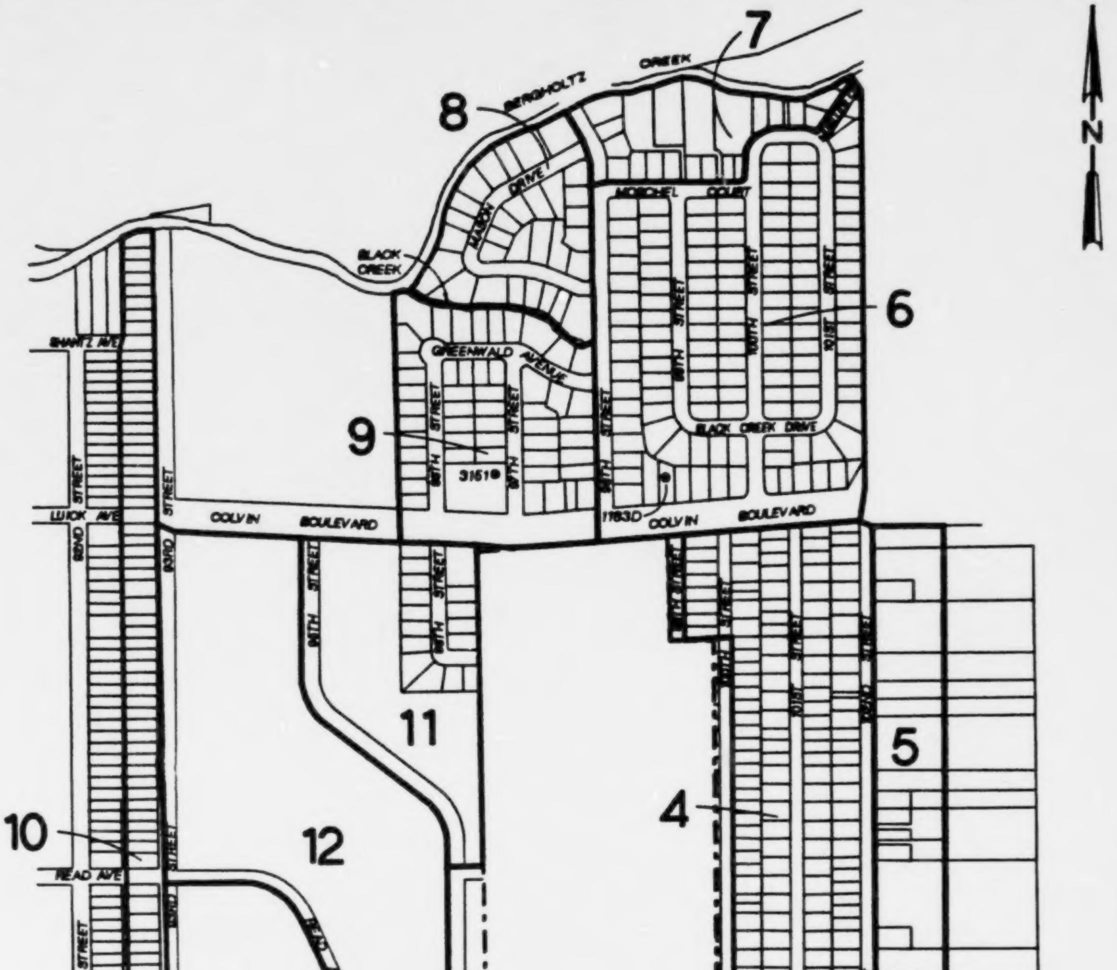
N
7
BERGHOLTZ CREEK
8
MARION DRIVE
MOSCHEL COURT
BLACK CREEK
6
99TH STREET
100TH STREET
101ST STREET
GREENWALD AVENUE
9
98TH STREET
97TH STREET
BLACK CREEK DRIVE
3151
1163D
SHANTZ AVE
LUICK AVE
92ND STREET
93RD STREET
COLVIN BOULEVARD
96TH STREET
95TH STREET
11
5
4
10
12
READ AVE
93RD STREET
WHEATFIELD AVE
102ND
13
2
UNDERWOOD RD
103RD ST EXT
CENTER RD
103RD STREET
3
5114
LITTLE NIAGARA RIVER
LASALLE EXPRESSWAY
BUFFALO AVENUE
COLVIN AVENUE
1151D
1154D
1

Figure 4-2
OVERBURDEN WELL LOCATIONS
SCALE: 1"=650'

LEGEND
—— EDA NEIGHBORHOOD BOUNDARIES (NUMBERED 1-13)
— · — FENCE LINE AROUND LOVE CANAL REMEDIATION SITE
● OVERBURDEN WELLS

SOURCE: NEIGHBORHOOD BOUNDARIES ADAPTED FROM THE PROPOSED HABITABILITY CRITERIA DOCUMENT (NYSDOH AND DHHS/CDC, 1986).

What inferences can be made regarding the Canal chemicals in EDA air if a period of prolonged heavy precipitation occurs? (Dr. Michael Stoline--Written Preliminary Comments, p. 12.)

Provide more detailed information on rainfall levels during the sampling period, with special reference to the levels of precipitation during 1975 and 1976, when chemical migration from the Love Canal was most obvious. (Dr. Michael Stoline--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: Sampling of indoor and ambient air was performed during 52 days between July 28 and December 13, 1987. The meteorological conditions that occurred during the July-to-December sampling period do not fully reflect the maximum historical annual extremes, particularly for such parameters as temperature and precipitation. However, these conditions were typical of the annual means and extremes expected for this period.

The maximum and minimum temperatures recorded during sampling were 87°F and 20°F, respectively. Both heated and unheated homes (i.e., occupied and unoccupied homes) were sampled under conditions approaching these extremes. The maximum and minimum temperatures occurring during this 5-month period were 91°F and 15°F, respectively.

Historical extreme temperatures were not expected during the study period. However, a meaningful comparison of recorded temperatures can be made with 30-year monthly mean temperatures. The 30-year monthly mean maximum and minimum temperatures range from 30°F to 81°F and from 17°F to 62°F, respectively.

Mean monthly precipitation values, based on data collected at the Niagara Falls International Airport, are shown in Table 4-2. For comparison, the precipitation totals for each month during the air monitoring study are included in Table 4-3.

Table 4-2

MONTHLY PRECIPITATION--HISTORICAL RECORD
NIAGARA FALLS INTERNATIONAL AIRPORT[a]
(inches precipitation)

Month/ Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	All Months
51						[b]2.09	4.09	1.09	2.38	1.65	6.06	3.41	
52	4.13	1.98	2.81	2.10	3.11	.23	1.84	4.32	1.81	.26	1.86	2.86	27.31
53	2.27	1.58	4.88	2.21	4.02	.60	3.63	4.85	3.94	.49	2.53	2.07	33.07
54	2.20	4.10	4.49	3.79	1.06	3.04	.55	8.96	2.07	6.77	3.57	3.81	44.41
55	1.93	2.07	3.92	3.00	2.27	.74	2.23	5.46	2.30	7.18	2.07	2.74	35.91
56	2.66	3.34	3.36	4.55	6.47	.47	3.59	7.38	3.13	.97	2.13	2.86	40.91
57	4.62	1.91	1.85	4.72	4.78	4.01	3.49	.79	3.03	1.33	2.33	4.04	36.90
58	3.12	4.12	.75	2.34	1.46	1.11	2.03	2.87	2.86	1.03	2.56	1.09	25.34
59	3.88	3.92	3.22	2.48	.70	1.50	.42	4.48	3.13	4.54	2.30	3.73	35.30
60	2.37	4.54	2.00	1.64	5.08	2.15	1.48						
61										[b].39	2.44	2.77	
62	[b]2.45									[b]2.18	[b]1.12	2.42	
63	[b]1.79	.56	1.81	2.76	1.79	1.46	3.50	6.00	1.06	.44	5.03	1.73	[b]27.93
64	1.77	1.33	3.50	3.81	2.88	1.85	[b].97						
68											*1.61	3.08	
69	2.76	.60	1.56	3.98	4.06	2.92	3.23	1.06	1.11	1.99	3.47	3.10	29.84
70	1.91	2.34	2.15	2.19	2.89	4.28	2.64	4.41	3.29	3.34	3.30	3.17	35.91
71	1.45	2.74	2.17	1.48	1.48	4.01	3.16	3.90	1.55	2.25	2.10	3.57	29.86
72	1.99	3.47	4.78	2.77	3.02	4.32	1.61	5.23	3.71	3.69	3.27	3.46	41.32
73	1.30	1.95	4.29	4.24	3.02	4.59	1.78	1.50	1.78	4.18	4.79	4.20	37.62
74	2.59	2.37	3.27	4.02	4.47	4.31	1.99	2.53	2.32	1.41	4.43	2.44	36.15
75	1.44	2.61	2.62	1.48	2.27	4.62	1.32	4.98	2.52	2.17	2.66	3.51	32.20

Table 4-2
(continued)

Month/ Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	All Months
76	2.87	2.26	4.96	3.32	4.09	4.86	3.94	1.01	2.34	2.42	1.08	2.29	35.44
77	1.76	.99	2.35	3.09	2.02	2.12	2.71	4.09	7.90	2.10	5.05	4.71	38.89
78	3.33	1.62	1.73	1.39	2.32	2.38	1.90	3.40	5.57	3.72	1.52	2.05	30.93
79	2.94	1.48	1.70	3.56	1.87	1.58	2.64	3.49	5.60	4.15	2.86	2.91	34.78
80	1.71	1.45	3.21	3.75	1.43	3.74	3.02	2.28	3.63	4.11	2.17	2.94	33.44
81	1.63	4.30	1.74	3.63	2.58	4.30	5.78	2.14	3.60	3.19	2.90	3.97	39.76
Period of Record (1951-1964, 1968-1981)													
Mean	2.46	2.40	2.88	3.01	2.88	2.72	2.65	3.75	3.07	2.76	3.02	3.04	35.01
S.D.	.898	1.181	1.202	1.011	1.420	1.538	1.155	2.105	1.578	1.867	1.247	.822	4.749
Total OBS	763	679	744	720	744	738	753	713	690	747	758	806	8,855

(a)--Data based on daily observations and compiled by the Global Climatological Branch, USAFETAC Air Weather Service.
(b)--Data based on less than full month's record.

Table 4-3

MEAN MONTHLY PRECIPITATION AND TOTAL MONTHLY PRECIPITATION[a]

For Period July--December 1987

Month	Mean Monthly Precipitation (inches)[b]	Total For Month 1987 (inches)
August	3.7	4.3
September	3.1	4.7
October	2.8	2.1
November	3.0	4.1
December	3.0	0.7[c]

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[a] Data recorded at Niagara Falls International Airport.

[b] Mean monthly precipitation based on data recorded over period 1951-1964, 1968-1981.

[c] Value represents total precipitation during the period of sampling (December 1-13).

Reports that chemicals were leaking from the landfill increased during the mid-1970s. During the 6-year period between 1972 and 1977, annual precipitation exceeded the historical annual average each year except 1975. Highest monthly precipitation occurred in September 1977; it was more than twice the monthly average.

Although less representative of the EDA, the precipitation recorded at Buffalo greatly exceeded the annual average over this same period of record. The precipitation during 1977 was 1.5 times the annual average. The highest monthly precipitation was 10.67 inches during July 1977, which is more than three times the average for this month.

The data in Table 4-3 indicate that, with the exception of October 1987, the precipitation during the air sampling period was greater than the historical mean monthly values.

A comparison of the data in both Tables 4-1 and 4-3 reveals that, although the monthly precipitation during August and September 1987 was significantly above the mean monthly value, ground water levels in the wells changed very little.

4.4 OTHER

4.4.1 Detection Limits and Selection of LCICs

COMMENTS: Statistical certainties (about whether LCICs are present in the EDA) can be obtained using only the upper range value of the quantifiable detection limits. Habitability decisions may have to consider LCIC exposure limits versus quantifiable detection limits. (Dr. Janick Artiola--Written Preliminary Comments, pp. 7-8.)

Assess the use of these LCICs. Can a probable determination of the prevalence of other chemicals from Love Canal be made? This assumption needs some resubstantiation in light of the study outcome and other current information. (Dr. Michael Stoline--Written Preliminary Comments, p. 12.)

There is an underlying assumption that any chemical associated with the LCICs does not present a significant hazard if the LCICs are present at levels below the limit of detection, i.e., 1.0 ppb. (Dr. Joan Daisey--Written Preliminary Comments, p. 8.)

Discuss the selection of indicator chemicals. (Dr. Carl Shy--Written Preliminary Comments, p. 6.)

RESPONSE: The evaluation approach and decision-making criteria used to select LCICs have been previously peer reviewed. Based on pilot study results, the air assessment was designed so that any detected LCIC was considered significant and reflected conditions different from areas outside the EDA. The LCICs were selected to represent a large number of chemicals originating from Love Canal. The selection of LCICs was based on factors discussed in the habitability criteria document (NYSDOH and DHHS/CDC, 1986), which did not include health risk. The habitability study was designed to determine whether the EDA is as safe as similar inhabited communities in Western New York State.

4.4.2 Interpretation of the Results

COMMENT: The finding that one home out of 562 in the EDA had measurable levels of air LCICs should be viewed in the perspective that, in the pilot study, 1 home out of 31 in the control area also had measurable levels. (Dr. David Schoenfeld--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: The pilot study results contributed to the design of the air assessment and are still an integral part of the overall study. The Commissioner of Health for the State of New York will consider both the pilot study and the air assessment results in determining habitability.

COMMENT: Is it not inconsistent to observe measurable levels of LCICs in soil but not in air? (Dr. Carl Shy--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: It was noted by Dr. Shy in the peer review meeting that LCICs, specifically chlorobenzenes, were detected in the EDA soil but not in the air. Selection of LCICs was based upon specific physical and chemical characteristics. The characteristics best suited for an air LCIC were different from those best suited for a soil LCIC and, therefore, the LCICs for the two media were different: 1,2-dichlorobenzene (DCB), TCB, and 1,2,3,4-tetrachlorobenzene (TeCB) were chlorobenzenes selected for soil while CB was selected for air.

However, even if LCICs were consistent between the two assessments, it would still be likely that concentrations would be detected in soil and not in the air influenced by this soil. The rate of volatilization of a compound from soil to the air is affected by many factors, including properties of the compound, soil properties, and environmental conditions. It is common to find concentrations of a compound in the soil at several orders of magnitude above those in the air immediately influenced by that soil. Therefore, it would not be inconsistent to detect low level compounds in the soil and not detect those same compounds in the air.

COMMENT: Concentrations of contaminants in air are highly variable, and even thorough studies such as this one cannot provide complete assurance that all potential occasions of detectable contaminant levels have been identified.

Even though the air study identified only one home in the EDA with measurable levels of indicator chemicals, if rehabitation occurs and if individuals continue to have concerns, it may be desirable to make information available on home ventilation devices that might be used to reduce soil-gas accumulation in homes. (Dr. Joan Daisey--Peer Review Meeting Comments, June 20, 1988).

RESPONSE: As discussed in Section 4.1.1 above, this study, as would any study, falls short of offering complete assurance that all potential occasions of detectable LCIC levels have been identified. However, in its discussion of issues raised during the peer review meeting, the TRC determined that the data obtained during the air assessment did not appear to indicate the need for installation of home ventilation devices.

4.4.3 Additional Information

Also included in this volume as Appendix E is the list of errata for Volume II.

Section 5.0
RESPONSES TO COMMENTS ON THE SOIL ASSESSMENT FOR INDICATOR CHEMICALS

This section briefly describes the peer review comments on Volume III, *Soil Assessment--Indicator Chemicals* (CH2M HILL, 1988b), and gives the responses to those comments. Both written preliminary peer review comments and verbal peer review comments made during the peer review meeting are addressed in this section. The peer review comments have been organized under the categories of "Design," "Methods," and "Results." Each comment is paraphrased, the peer reviewer making the comment is referenced, and the response to the comment is given. Where lengthy responses are required, the response is summarized in this section, while the full response is provided in an appendix.

5.1 DESIGN

5.1.1 Statistical Sampling Design

COMMENT: Since the soil LCIC assessment had a much lower percentage of nonquantifiable results than anticipated, why was a nonparametric analysis the only analysis conducted? (Dr. Michael Stoline--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: The nonparametric analysis was adopted in part because of the ability of this type of analysis to handle nonquantifiable (nondetect) data. In addition, the nonparametric analysis requires fewer assumptions about the distribution of concentration values. The performance of a nonparametric analysis, as measured by the power achieved for a given sample size, is nearly as great as a parametric test when the assumptions of the parametric test are met, and much greater when those assumptions are not met.

In spite of the better than expected performance of the laboratories, a parametric analysis still risks misinterpretation of the data if the statistical distribution is inappropriate. A more complete discussion and review of the decision to use nonparametric analyses is presented in Appendix F.

COMMENT: The pilot study peer review indicated that the sample sizes would be independently reviewed. Was this done? (Dr. Michael Stoline--Written Preliminary Comments, p. 14.)

RESPONSE: The sample size specified for the full study was reviewed by the TRC and by statistical consultants. As the retrospective power analysis presented in Volume III showed, the design goal of 90 percent power to detect an order of magnitude difference was exceeded with the sample sizes used.

COMMENT: Explain the changes made for the simulation model since the pilot study. (Dr. Michael Stoline--Written Preliminary Comments, pp. 5-6.)

RESPONSE: The simulation model was originated prior to the pilot study to aid in the decision of how to design the soil assessment comparison study. The simulation model evolved as the needs of the project evolved; therefore, the use and characteristics of the model followed the phases of the project: pre-pilot, pilot study design, post-pilot design, and soil assessment study data analysis.

Before the pilot study began, the main purposes of the model were to (1) aid in deciding which statistical test to use for comparison and (2) estimate the number of samples needed to achieve the power required by the habitability criteria. Because the distribution of the data was unknown, several potential data distributions were used to generate simulated data: the generalized extreme value, the mixed exponential, the Pearson type III, the lognormal, and the normal distribution. Each of these distributions was regarded as a potential model (with some censoring of below-detection-limit data) of the comparison areas. One of several types of shifts (i.e., change in location, scale, or both) was applied to each distribution to simulate an EDA area.

As reported in the pilot study report (CH2M HILL, 1987d), a variety of potential test statistics were examined for use in the soil assessment for indicator chemicals. These included Fisher's Exact test, Student's t test, Wilcoxon rank sum test, Moses scale test, Shorack's APF test, and Mood's test. Of these, the Wilcoxon rank sum test proved to be the most robust to the distribution of the data.

The pilot study results demonstrated that the percentage of nonquantifiable data would be lower than seen in previous studies. It also showed that the interlaboratory variability was a major component of the variability.

The simulation model was modified to estimate the sample sizes required for the full LCIC soil assessment. The distribution that best fit the pilot study data was a lognormal mixture distribution, which was used for further simulations to estimate the sample size required to achieve the power criteria. The other candidate distributions were dropped.

During the sampling for the full LCIC soil assessment, the model was further modified to include the analysis of data by the Wilcoxon test, blocked across laboratories. The test that was implemented is discussed in Appendix B of Volume III.

After the analysis of the LCIC soil assessment data, a further simulation was conducted to estimate the retrospective power of the sampling and analysis as carried out. The results of this simulation are given in Appendix G. This simulation used a lognormal distribution fitted to the comparison area data, as seen in the sampling program.

Note that the fitted parametric distributions were used only for the purposes of estimating the power of statistical tests. No attempt was made to perform any of the comparisons using the parameters of the fitted distributions. The parameters of the fitted distributions, while adequate for the generation of artificial data, did not fit well enough to adequately represent the actual data for purposes of comparison.

COMMENT: Did flagging samples compromise "blind" analysis of samples by laboratories? (Dr. David Schoenfeld--Written Preliminary Comments, p. 1, and Consensus Comment--Peer Revew Meeting, June 20, 1988.)

RESPONSE: The pilot study indicated that samples from Sampling Area 1 may contain concentrations of LCICs sufficiently elevated to damage the calibration of the laboratory's Gas Chromatograph/Mass Spectrometer (GC/MS). This would cause delays in the analysis of further samples while the instruments were recalibrated. To avoid this, all samples from Sampling Area 1 were flagged as being potentially elevated so that the laboratories could perform an initial screening analysis. An equal number of samples selected at random from all other areas were given the same flag to be screened. This preserved the "blind" aspect of analysis by preventing the laboratories from knowing the area from which a sample came.

5.1.2 Selection of Census Tracts

COMMENTS: Document the criteria used to select the two Niagara Falls comparison areas, Census Tracts 221 and 225. (Dr. Michael Stoline--Preliminary Written Comments, p. 14.)

Specifically, why was Census Tract 225 selected since it is in such close proximity to the EDA? (Dr. Michael Stoline--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: This documentation is provided in Section 6.3, "Selection of Comparison Areas" (pp. 6-13 through 6-20), in Volume I, *Introduction and Decision-Making Documentation* (ICAIR and CH2M HILL, 1988). Specifically, an area as close to the EDA as possible was selected to provide a comparison area with the same water supply and the same potential airborne contaminant sources as the EDA. However, Census Tract 225 complies with the criterion for selection by being more than one-half mile from the Love Canal site proper and other known chemical waste dump sites.

5.2 METHODS

5.2.1 Method Documentation (QAPPs)

COMMENT: It is not clear how the QAPP and the final revised version of the QAPP relate to each other. The revised version appears to be a complete replacement of the original. However, the revised version omits any mention of the matrix spike (MS) samples or the blind quality control (QC) samples. (Dr. Joan Daisey--Written Preliminary Comments, p. 7.)

RESPONSE: Two final QAPPs relate to the soil LCIC study addressed in Volume III. The first is entitled, *Soil Sample Collection and Preparation QAPP (Final Revised Version)* (CH2M HILL, 1987b), and the second is entitled, *Soil Sample Laboratory Analysis QAPP* (CH2M HILL, 1987c). These two QAPPs addressed the field and laboratory phases of the study, respectively. It was not the intent of the field QAPP to address the MS or blind QC sample analyses, since these are laboratory QC samples and not field QC samples.

COMMENT: Document any changes in the study methods made during implementation of the QAPPs. (Dr. Janick Artiola--Written Preliminary Comments, p. 3.)

RESPONSE: Changes in sampling or analysis procedures made during implementation of the two respective QAPPs involved responses to problems encountered in the field or in the laboratories. These include problems with (1) coordinating the schedules for sampling and analysis, resulting in a change in the holding time requirements (discussed in Volume III: Section 5.2 and Appendix D); (2) extruding samples at the sample preparation laboratory; this problem was solved by taking replacement samples (see Volume III, pp. 6-1 and 6-4); (3) intralaboratory split sample allocation (see comment and response in Section 5.2.2 below); (4) blank interference in the laboratories for which several corrective actions were taken (see Volume III, p. 6-13); and (5) general analytical procedures in one laboratory, which were responded to by collecting contingency samples (not utilized) and sending the original samples to another laboratory for analysis (see Volume III, pp. 6-4 and 6-14).

5.2.2 Sample Collection and Preparation Methods

COMMENT: What was the depth of the soil core relative to what the peer reviewers had previously recommended? (Dr. Randall Charbeneau--Written Preliminary Comments, p. 2.)

RESPONSE: During the peer review of the pilot study, the peer reviewers recommended a soil core depth of 12 inches. The depth criterion implemented was a 12-inch depth with a minimum of 7 inches where 12 inches could not be achieved. The minimum of 7 inches was based on the minimum required volume of soil for analysis.

As can be calculated from the numbers in Table 5-1, 72 percent of the soil samples collected for LCIC analysis had a column length (core depth) of 12 inches, and 11 percent had a column length of 11 inches. Samples with a column length of less than 11 or 12 inches were collected from areas in which the fill soil was not deep enough to provide a longer soil column. These conditions were reported in the pilot study report.

COMMENT: How much soil was collected from each location? Were the soil materials (cores) segregated (sieved) in any manner? How were the roots (plant materials) removed? How much of the soil sample collected was used for analysis? Was there any effort to determine the adequacy of the sample mixing and splitting techniques used vis-á-vis the representativeness of the soil core collected? (Dr. Janick Artiola--Written Preliminary Comments, p. 2.)

RESPONSE: The soil cores taken contained approximately 60 to 100 grams of soil, depending on the length of the soil column that could be obtained (see Table 5-1 for further information on actual soil column lengths). The soil core materials were not

Table 5-1

LENGTH OF SOIL COLUMN OBTAINED BY NEIGHBORHOOD AND COMPARISON AREA
SOIL ASSESSMENT--INDICATOR CHEMICALS

Area	Neighborhood	Length of Soil Column (Inches) 7	8	9	10	11	12	Total
EDA	1	1	1	2	1	1	38	44
	2	1	0	0	4	5	34	44
	3	0	4	2	2	2	31	41
	4	3	1	5	4	5	45	63
	5	0	0	2	5	0	23	30
	6	1	5	4	3	7	53	73
	7	3	0	0	0	2	28	33
	8	1	0	2	3	4	19	29
	9	0	4	4	1	2	19	30
	10	1	1	1	2	2	22	29
	11	0	0	2	3	4	24	33
	12	0	1	4	0	14	46	65
	13	2	3	7	3	10	48	73
Cheektowaga and Tonawanda		1	1	1	2	5	51	61
Census Tract 221		3	1	1	9	12	41	67
Census Tract 225		1	5	5	8	9	38	66
TOTAL		18	27	42	50	84	560	781

segregated or sieved. Roots and other plant material were removed by cutting and lifting them off with a clean knife. While the complete collected soil sample was sent for analysis, only 20 grams were needed for analysis (see Appendix A of the soil sample analysis QAPP, CH2M HILL, 1987c).

The procedure for mixing the samples was developed as part of the soil pilot study. Analytical results were used to determine the mixing time that obtained optimum soil homogeneity while minimizing volatile and semivolatile losses. Further information on the study conducted to determine the optimum sample preparation protocol is given on page B-11 in Volume I of the pilot study report (CH2M HILL, 1987d). A retrospective quantification of the variability of the sample mixing and splitting techniques is difficult because of the degree of variability introduced through the sample extraction and analysis process.

COMMENT: Clarification and full, detailed documentation from the EPA National Enforcement Investigation Center (NEIC)/Techlaw are needed regarding what was observed during the field audits and whether the sample collection teams followed the sampling protocols in the sample collection and preparation QAPP (CH2M HILL, 1987b). (Dr. Joan Daisey--Written Preliminary Comments, pp. 1-2.)

RESPONSE: Several field and laboratory audits were conducted during the soil LCIC study. Each audit comprised two parts: the evidentiary documentation procedures audit that NEIC/Techlaw was responsible for and the technical procedures audit that the EPA Environmental Monitoring Systems Laboratory-Las Vegas/Lockheed Engineering and Management Services Company (EMSL-LV/LEMSCO) conducted. NEIC/Techlaw's evidentiary audit summary report, contained in Appendix G of Volume III, was based on reports of several individual NEIC/Techlaw field and laboratory evidence audits. Similarly, EMSL-LV/LEMSCO's technical procedures audit summary report, contained in Appendix H of Volume III, was based on several individual field and laboratory technical audit reports. Including these additional audit reports in Volume III would have made the report unmanageably large and less amenable to widespread public distribution and use. Copies of the individual audit reports may be obtained upon request from EPA Region II through a Freedom of Information Act (FOIA) request.

COMMENT: The previous peer review recommended that the soil material clinging to the grass be shaken off and included. Was this done? (Dr. Joan Daisey--Written Preliminary Comments, p. 6.)

RESPONSE: The field sampling crews were not directed to shake the removed sod layer, so the loose soil could be included in the sample. However, the following procedure, reported on page B-12 of Appendix B of the soil LCIC QAPP (CH2M HILL, 1987b), was followed:

> "1. Remove knife from packaging. Clear the area to be sampled of any surface debris with the knife (twigs, rocks, litter, snow, etc.). If the sampling area is covered with grass or weeds, remove a small piece of sod with the knife (3 to 4 inches square) and place it to one side, away from the sampling area...."

COMMENT: While it is true that intralaboratory variability can be assessed by the use of other QC samples, it is not clear how the oversight of the intralaboratory split samples occurred. Were the Standard Operating Procedures (SOPs) not sufficiently clear or was the split done so infrequently that it was forgotten? (Dr. Joan Daisey--Written Preliminary Comments, p. 8.)

RESPONSE: The sample preparation team was given a daily schedule, like the one shown in Table 5-2, that indicated which laboratories were to receive samples and splits. As can be seen, the schedule did not indicate which samples were to be split. This was purposely done to allow the soil preparation laboratory the freedom to select a full column (i.e., 12 inches) of soil as was needed to provide a sufficient amount of soil for the analysis of both halves; the actual length of soil column that

Table 5-2

EXAMPLE SAMPLE PREPARATION SCHEDULE PROVIDED DAILY TO THE SAMPLE PREPARATION TEAMS
SOIL ASSESSMENT--INDICATOR CHEMICALS

Day 5

Station Number	Preparation Team	Analytical Laboratory
759	2	CEC
760	2	AQI
765	2	CAA
766	2	CEC
282	2	AQI
283	2	CAA
288	2	AQI
289	2	MGM
355	2	AQI
356	2	MGM
360	2	VER
361	2	CEC
362	2	AQI
461	2	VER
462	2	CEC
469	2	CEC
470	2	AQI
473	2	NUS
Split 3	2	EMS
Split 4	2	CEC
1019	2	CEC
1115	2	NUS
1222	2	AQI

a particular location could yield could not be determined before sample collection began. While the schedule designated that a split had to go to a certain laboratory, it did not indicate intralaboratory, splits, i.e., that the original half and the split half were to go to the same laboratory. As a hypothetic example, assume that both Splits 3 and 4 in Table 5-2 were to be intralaboratory splits. On Day 5, the sample preparation crew selected samples from Station Numbers 282 and 283 to be split because these samples had full columns. The original halves of these samples were destined for laboratories AQI and CAA, respectively. Splits 3 and 4 were designated for laboratories EMS and CEC. Thus, the intended intralaboratory splits were not sent to the same laboratory as intended. In general, although the schedule was carefully followed, most of the intended intralaboratory splits were not sent to the same laboratory.

5.2.3 Sample Analysis Methods

COMMENT: Did modifications to the analytical method after the pilot study actually result in lower detection limits? (Dr. Michael Stoline--Written Preliminary Comments, pp. 11-12.)

RESPONSE: Yes, the detection limits were lowered by changes in the analytical method after the pilot study. Qualitatively, this is demonstrated by the detection of low-level concentrations in the blind QC samples prepared by EMSL-LV. The quantitative estimation of detection limits is discussed in Appendix H.

COMMENT: It appears from the box plots that 2-chloronaphthalene (CNP) is ubiquitously present at levels below 0.2 ppb. Is this the case? Did CNP routinely appear in the method/holding blanks? This would indicate that the source may be laboratory contamination rather than true concentrations in field samples. Why weren't the concentration results for field samples corrected for the blank concentration? (Dr. Janick Artiola--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: The Method/Holding Blank (MHB) and field handling blank (FHB) results are discussed in Appendix I, "Chemical Data Quality Assessment." Considerable effort was expended to keep the level of laboratory contamination as low as possible. For example, all laboratories were provided with a common supply of solvents and reagents that had been subjected to extensive analyses to demonstrate that the background levels of LCICs and LCIC interferences were as low as possible. 2-CNP was detected in most MHBs at a mean concentration below 0.1 ppb, which is well below the 0.5-ppb blank acceptance level for the project. This indicates that CNP was a ubiquitous laboratory or solvent/reagent contaminant present at very low levels. (See Appendix F of Volume III for more details.)

Correcting sample concentration results using MHB concentrations is never routinely performed for this type of chemical analysis. The procedures used in this study are primarily based on those required for the EPA Superfund Contract Laboratory Program (CLP). In the CLP semi-volatile analysis procedure, results of the MHB analyses are reported along with the field sample concentrations. This allows the end user of the data to decide how best to handle the MHB results. It is often observed that the concentration of a compound in a field sample is *lower* than that observed in the MHB. If these results were blank corrected, the reported concentration would be *negative*. In any event, the balanced design of the statistical comparisons performed in this study would tend to negate the effect of low-level laboratory contamination. It was decided that correcting field sample results for the MHB and the FHB concentrations was not advisable.

5.3 RESULTS

5.3.1 Consistency of Data Qualifiers

COMMENT: Some of the data qualifiers in the data base were not used consistently by the six laboratories. Although this would not have an effect on the Good data, it would be appropriate to make the qualifiers for the other data consistent in the final data base. (Dr. Joan Daisey--Written Preliminary Comments, p. 6.)

RESPONSE: Although it is desirable to have consistent qualifiers in the data base, it is generally not good practice to change data qualifiers assigned by the chemist in the laboratory at the time of analysis. Problems could have been encountered that (1) could not be indicated using the data qualifiers specified, (2) are not otherwise documented, and (3) could have had an effect on the quality of the data. The few qualifiers that were used inconsistently were detailed qualifiers, which did not have an effect on the assignment of the overall data usability qualifiers of Good, Uncertain, and Bad.

5.3.2 Blank Sample Data

COMMENT: The report did not present data from the analysis of the FHBs used to show that samples were not contaminated during the sample collection phase of the study. A quantitative statement about how much higher the FHBs were than the MHBs should also be included. The statement that the MHBs all showed very low levels of contamination should also be quantified. Were they an order of magnitude lower than the limits given, or 50 percent lower? (Dr. Joan Daisey--Written Preliminary Comments, pp. 2-3.)

RESPONSE: Table I-11 of Appendix I summarizes the FHB results and allows a comparison of the FHB results with the MHBs extracted in the same batch. Most LCICs show only a very slight increase in concentration of the FHBs compared to the MHBs. The largest effect is for DCB, which increased by an average of 0.1 to 0.2 ppb in all laboratories. All other increases were less than 0.1 ppb.

There are two possible causes for this marginal effect. The first possibility is that there were low levels of LCICs in the FHB matrix. The MHBs were based on a sand matrix carefully prepared and provided by EPA to be used as an MHB material. The FHBs were based on a soil matrix selected to be similar in composition to soil from the Love Canal area. While this soil was demonstrated by chemical analysis to be acceptable as a blank matrix, there could be low levels of LCICs present. Another possibility is that the slight elevation of FHB concentrations over the MHB concentrations are caused by small amounts of contamination experienced during the sample collection, soil preparation, transportation, or laboratory sample extraction and cleanup processes. This small degree of contamination did not trigger any corrective action during the laboratory phase of the project and is not expected to degrade the usefulness of the results since the contamination levels observed are less than the precision of the analysis method.

Table I-10 of Appendix I contains a summary of the MHB results for each LCIC and each laboratory. This summary is based solely on the computerized MHB equivalent concentrations reported by the laboratories and does not include the results of applying the MHB interpretation rules. All MHBs reported in the study were accepted by the EMSL-LV when the Selected Ion Current Profiles (SICP) were scrutinized.

The slightly elevated levels of DCB, especially notable in Laboratory 8, were caused by minor laboratory contamination. The high concentrations of beta-hexachlorocyclohexane (B-BHC) and gamma-BHC (G-BHC) were caused by the ubiquitous interferences arising from the laboratory detergent used to clean glassware. All laboratories experienced this interference to some extent and had to be exceedingly careful to either minimize the concentrations of the interference or chromatographically separate it from the BHCs.

5.3.3 Data Completeness

COMMENT: What was the data completeness for field and QC samples relative to the 90 percent completeness goal in the QAPP

(CH2M HILL, 1987b and c)? (Dr. Janick Artiola--Written Preliminary Comments, p. 4.)

RESPONSE: For field samples, a total of 894 samples were planned and 781 were analyzed. This corresponds to a completeness of 87.4 percent. For field QC samples, 76 FHBs and 83 field splits were planned for a total of 159 field QC samples. There were 68 FHBs and 73 field splits analyzed for a total of 141 field QC samples analyzed. This corresponds to a completeness of 88.7 percent. For laboratory QC samples, the completeness was 100 percent, in the sense that all laboratories analyzed all laboratory QC samples at the planned frequency. The percentage of the laboratory samples meeting the QC criteria is detailed in Table I-5 of Appendix I.

5.3.4 Actual Versus Planned Sample Sizes

COMMENT: The actual sample size in many sampling areas varied from the 75 samples discussed in the design. Did this reduce the power of the statistical tests? (Dr. Michael Stoline--Written Preliminary Comments, pp. 1-3.)

RESPONSE: The simulation study conducted after the pilot study suggested that, with the distributions seen in the pilot study, approximately 50 samples would provide 90 percent power of detecting an order-of-magnitude difference. Additional samples were allocated to sampling areas to provide a contingency for sample loss. Retrospective simulation of the power indicates that, even with the loss of samples from Laboratory 4, the power exceeded the goal of 90 percent for detecting an order-of-magnitude difference, as shown in Tables K-13 and K-14 of Volume III.

COMMENT: Reaffirm in Volume V that the originally planned statistical analyses of the data remain the main or central analyses despite the additional sensitivity analyses, etc., requested by the peer reviewers. (Dr. Michael Stoline--Peer Review Meeting Comments, June 20, 1988).

RESPONSE: Appendix J of this volume presents the additional sensitivity analyses and their results, which are supplemental to those presented in Section 6.0 of Volume III.

5.3.5 Neighborhood Power Calculations

COMMENT: Statistical tests should be performed using the original neighborhoods. These analyses may require additional analyses. For instance, if some of the original neighborhoods are not contaminated (as determined by the results of the statistical test), one would want to calculate retrospective powers for these neighborhoods to show that they passed the 90 percent power rule. (Dr. David Schoenfeld--Written Preliminary Comments, p. 5.)

RESPONSE: Tables K-13 and K-14 in Appendix K of Volume III present the results of a retrospective power analysis for the univariate and multivariate comparisons for the sampling areas. Appendix G of this volume presents the retrospective power for the univariate and multivariate comparisons based on a lognormal mixture fit for the sampling areas and the neighborhoods. The sampling area power calculations are performed with a nominal sample size of 75 in both the comparison and EDA areas, while the neighborhood power calculations are performed with a nominal sample size of 35 in both areas. Since actual sample sizes at both aggregation levels often exceeded these numbers, the power estimates are biased low.

5.3.6 Magnitudes of the Differences and Other Percentiles of LCIC Concentrations

COMMENTS: Highlight differences of magnitude of statistically significant differences. (Dr. Carl Shy and Dr. Michael Stoline--Written Preliminary Comments, pp. 5 and 17, respectively.)

Report other percentiles of LCIC concentrations such as the 90th or 95th. (Dr. Michael Stoline--Written Preliminary Comments, p. 16.)

Fit a lognormal or lognormal mixture distribution to the data and report the upper percentiles for the fitted distribution. (Dr. Michael Stoline--Written Preliminary Comments, p. 16.)

RESPONSE: Tables in Appendix G show both the empirical and the fitted percentiles of the distributions for each neighborhood. These tables can be used to an approximate magnitude for statistically significant differences. Calculation of the differences is complicated by the fraction of non-detect values in each distribution and is, therefore, not presented.

5.3.7 Analysis of Outlying Values

COMMENTS: There is an impression that, for most LCICs, there are more outlying high values in the EDA areas than in the control areas. A p-value for this hypothesis should be calculated. (Dr. David Schoenfeld--Written Preliminary Comments, p. 3.)

The sensitivity analysis at 1.0 ppb (shown in Table K-11 of Volume III) satisfies my concerns about outliers, except for possibly the LCIC TCB. Run a sensitivity analysis at 2.0 ppb for TCB. (Dr. David Schoenfeld--Peer Review Meeting Comments, June 21, 1988.)

RESPONSE: The influence of high values is examined by the sensitivity analysis in which all values less than 1.0 ppb are set equivalent to non-detect values. The results of this analysis are shown in Tables K-4 through K-12 of Volume III. As discussed during the peer review, 1.0 ppb is an appropriate cutoff value for most LCICs. However, TCB appears to have generally elevated concentrations so that 2.0 ppb may be more appropriate for this compound. Table J-3 of Appendix J gives the results for a 2.0-ppb cutoff value for all LCICs including TCB.

The statistical test used is commonly referred to as comparing the medians of two distributions. As discussed in Volume III, this test more precisely tests whether a sample concentration from the EDA is equally likely to be greater than or less than a sample concentration from the comparison area. This test actually uses the whole probability distribution of the concentration values from both areas.

Two sensitivity analyses have been conducted to examine whether the test is dominated by either the low values or the high values. The first of these removed the 10 percent highest values from the distribution in each comparison area. If fewer comparisons are significant with this change in the data, then high values tend to dominate the comparison, while if more comparisons are significant, then low values tend to dominate the comparisons.

The second sensitivity analysis to examine the influence of outliers sets all low values, those less than 1.0 (or 2.0) ppb, to be equivalent to a nonquantifiable value. Thus, the lowest part of the distribution was forced to be the same. If fewer comparisons are significant with this change in the data, then low values tend to dominate the comparison, while if more comparisons are significant, then high values tend to dominate the comparisons.

Note that while complementary, the two sensitivity analyses have different definitions of low and high. The first analysis defines upper 10 percent. The second analysis defines low and high variably: The range of low values can be from 50 percent to over 90 percent of the sample concentrations, depending on the number of samples with concentrations below the cutoff (1.0 or 2.0 ppb) for each sampling area and each LCIC.

COMMENT: A more detailed explanation of the purpose of each sensitivity analysis should be provided. (Dr. David Schoenfeld--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: Explanations of each of the sensitivity analyses are given in Appendix K. Sensitivity analyses were conducted on the following data sets:

- Data sets including data classified as Uncertain
- Data sets treating all concentrations below 1.0 ppb as non-detects
- Data sets deleting the upper 10 percent of the concentrations
- Data sets in which the ion identification criteria are "relaxed"
- Data sets treating all concentrations below 2.0 ppb as non-detects

COMMENT: Provide tables for each EDA sampling area that summarize the results of the central analysis and all pertinent sensitivity analyses reported in this volume and in Volume III. (Dr. David Schoenfeld--Peer Review Meeting Comments, June 20-21, 1988.)

RESPONSE: Appendix K presents seven tables--one for each EDA sampling area--that summarize the results of all of the sensitivity analyses that were reported in this volume and in Volume III. The explanations of the issues addressed by each sensitivity analysis are also contained in Appendix K.

5.3.8 Correcting for Chance Outcomes of the Univariate Tests

COMMENT: Construct a table similar to Table 6-9 in Volume III to display the results of the univariate comparisons with a Bonferroni correction for the number of LCICs. (Dr. Michael Stoline--Written Preliminary Comments, p. 10.)

RESPONSE: Figures J-1 and 2 of Appendix J give a graphical presentation of the Bonferroni corrected contrasts for eight LCICs. Other corrections can be easily obtained by use of the table of p-values (Volume III: Table K-1). For example, a 5 percent level of significance is indicated for comparisons with a p-value of 0.05 or less. With the Bonferroni correction for eight LCICs, this level becomes 0.006 (0.05/8), so that any comparison with this level or less is considered significant (EDA greater than comparison area).

5.3.9 Spatial Analysis

COMMENT: Evaluate the effectiveness of the dioxin study in accounting for hot spots, which were not addressed in the soil LCIC study. (Dr. Randall Charbeneau--Written Preliminary Comments, p. 5.)

RESPONSE: Although the soil assessment for indicator chemicals was not designed to find locally contaminated areas, the random allocation of samples to neighborhoods assumed that there were no major spatial trends in indicator chemical concentration.

Appendix L discusses spatial analyses performed to check this assumption. The LCIC soil assessment data were analyzed by examining a Spearman correlation of concentration with distance from the Canal and by using the geostatistical method of Kriging. Neither method demonstrated any spatial patterns of sufficient magnitude to invalidate the assumption of no major spatial trends.

COMMENT: Produce a graph of sample concentration by geographical coordinate. (Dr. David Schoenfeld--Written Preliminary Comments, pp. 4-5.)

RESPONSE: The results of analysis of each sample are given with the sample location in Appendix I of Volume III. One set of maps will be placed on display for the public's review at the NYSDEC's offices in Niagara Falls.

COMMENT: Examine the Spearman correlation of estimated concentration with distance from the Canal. (Dr. David Schoenfeld--Written Preliminary Comments, p. 5.)

RESPONSE: A spatial analysis of the concentration data was performed and no spatial trends were identified. The spatial analyses are reported in Appendix L.

COMMENTS: Determine whether EDA Sampling Areas 2 and 3 are downslope of the Love Canal or in or near a former swale downstream from the Canal. Determine the transport mechanism for detectable concentrations of soil LCICs. (Dr. Randall Charbeneau--Peer Review Meeting Comments, June 20, 1988.)

Determine if EDA Sampling Areas 2 and 3 are downwind of the Love Canal, (Public--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: These comments were discussed at the June 21, 1988, TRC meeting (see TRC Meeting Minutes). The TRC felt that such analyses were beyond the scope of the study. The purpose of the study was not to determine the mode of transport but simply to determine whether concentrations of the selected compounds in the EDA are different from concentrations in areas not affected by a chemical landfill.

COMMENT: A statistical comparison should be performed using the original neighborhoods rather than the sampling areas. (Dr. David Schoenfeld--Written Preliminary Comments, p. 5.)

RESPONSE: Results of the neighborhood comparisons are reported in Appendix M.

5.3.10 Additional Information

Also included in this volume as Appendix N is the list of errata from Volume III.

Appendix O provides a description of the data base used in the soil assessment for indicator chemicals.

Section 6.0
RESPONSES TO COMMENTS ON THE SOIL ASSESSMENT FOR 2,3,7,8-TCDD

This section briefly describes the peer review comments on Volume IV, *Soil Assessment--2,3,7,8-TCDD* (CH2M HILL, 1988c), and gives the responses to those comments. (2,3,7,8-TCDD is also referred to as dioxin throughout this document.) Both written preliminary peer review comments and verbal peer review comments made during the peer review meeting are addressed in this section. The peer review comments have been organized under the categories of "Design," "Methods," "Results," and "Other." Each comment is paraphrased, the peer reviewer making the comment is referenced, and the response to the comment is given. Where lengthy responses are required, the response is summarized in this section while the full response may be provided in an appendix.

6.1 DESIGN

6.1.1 Representativeness of Samples and Rationale for Selection of Sampling Media

COMMENT: The splitting of samples was not done in an unbiased manner, i.e., using a soil sample splitter. (Dr. Janick Artiola--Written Preliminary Comments, p. 3.)

RESPONSE: A cone splitter was originally planned to be used at the homogenization laboratory. When soil with a high-moisture content was encountered in a large percentage of the samples, the method of homogenizing the samples was changed; the homogenization was done manually both in Las Vegas in 1986 and in the field in 1987. A cone splitter would not have been effective with the high-moisture-content samples.

The results of the archive sample analysis versus the associated original sample analysis indicated that the comparability was good. In addition, the archive sample taken from the sampling location that had dioxin at concentrations above the 1.0-ppb level was homogenized and split into five aliquots. Each of these aliquots was analyzed, and the results were 17.3, 19.9, 20.2, 20.9, and 21.2 ppb, with a mean of 19.9 ppb, indicating relatively close agreement.

COMMENTS: Appendix A of the QAPP indicates that, during field sampling, pieces of soil larger than 0.3 centimeters would be excluded. How was this done? Was a sieve used to segregate sizes? If so, was a record kept of the percentages (by weight or volume) of soil excluded from each sample collected? This is biased exclusion of soil particles. The unbiased but systematic exclusion of soil materials (other than live plant tissue) should be made using sieves. (Dr. Janick Artiola--Written Preliminary Comments, pp. 3-4.)

There is major uncertainty in the representativeness of the soil samples collected and the premises and assumptions that were used. Although much effort was placed in the actual logistics and mechanics of the soil sample statistical design, sample tracking, and QC procedures, less thought was used in the definition of what would constitute a representative soil sample. Less care was taken to provide a truly unbiased sample collection and sample preparation prior to chemical analysis. (Dr. Janick Artiola--Written Preliminary Comments, p. 6.)

RESPONSE: The QAPP (CH2M HILL, 1986 and 1987e) called for the removal of twigs as well as stones larger than 0.3 centimeters, mostly for practical reasons. It was known from other dioxin sampling efforts that these objects were not amenable to the method of homogenization (blending) that was to be used. In addition, these materials interfere with the analytical method and are typically set aside in the laboratory. Also, since it is highly unlikely that dioxin would be found within the stones, any bias of the results caused by removing stones in the soil samples would give a higher than actual concentration of dioxin in the soil layer; i.e., the actual concentration would perhaps be slightly lower than that reported.

COMMENTS: Reasons for the arbitrary exclusions of the "sod" layer were not properly explained. Use of the sod layer is justified based on this statement in the report:

> "Under the direction of the TRC, the top 2 inches of soil were selected for sampling. This selection was based on a consideration of the most likely exposure mechanisms. Two common activities have been identified as probable means by which human exposure of soil would occur: (1) children playing and (2) adults gardening, etc." (CH2M HILL, 1988c)

These statements are based on a questionable premise--that gardening and child-playing activities take place only in the top 2 inches of soil.

The soil zone sampled was the most active (biologically and chemically) and was, therefore, the least likely to show levels of dioxin because of ongoing degradation. If you were really only interested in the top 2 inches of soil, perhaps a more direct and cost-effective approach would have been to add 2 inches of clean topsoil to the entire EDA. A better approach would have been to sample the top 12 inches of soil. This would have provided a more realistic and easier-to-accept buffer zone between any remaining buried dioxin-contaminated soil and the future inhabitants of the EDA. (Dr. Janick Artiola--Written Preliminary Comments, pp. 6-7 and 9.)

Does the absence of samples deeper than 2 inches raise any concern? (Dr. Carl Shy--Written Preliminary Comments, p. 7.)

RESPONSE: Dioxin is not readily biodegradable, but it does undergo photolysis in the presence of hydrogen donors and ultraviolet light. It is strongly bound to the organic matter in soils; typically, the organic fraction of the soil would decrease with increasing depth.

The selection of the top 2 inches of soil was based on a standard protocol used by EPA Region II for dioxin sampling in residential areas to determine if there are levels of concern in the accessible surface soils. This protocol has been reviewed and approved by the CDC and the Agency for Toxic Substances and Disease Registry (ATSDR). The level of concern for 2,3,7,8-TCDD is based on exposure to "accessible" residential surface soils containing concentrations of dioxin at or above 1.0 ppb. The health effects associated with dioxin and the relevant exposure patterns for soil, particularly those for children, were considered in establishing the level of concern.

The level of concern established by Kimbrough et al., summarized in Appendix P, was specifically developed for use at Missouri dioxin sites, although it applies generally to dioxin sites in residential areas, since exposure patterns are typical of residential areas and are not site-specific. Different levels of concern are applied for accessible surface soils at commercial and agricultural sites.

It is understood that adults gardening, etc., would come into contact with soil at depths greater than 2 inches. Adult residents would also come into contact with soils at depths of several feet if they were transplanting trees or doing construction-related activities. However, the top 2 inches of soil presents the portion of the soil column that adults and children most frequently come in contact with, and thus is a more appropriate depth to reflect long-term exposure and chronic effects. Appendix Q summarizes the assumptions used to calculate the level of concern.

6.1.2 Assumed Hot Spot Size

COMMENT: The assumed size of a hot spot seems large unless a great deal of soil material was transported. (Dr. Randall Charbeneau--Written Preliminary Comments, p. 5.)

RESPONSE: The size of the target hot spot was discussed extensively by the TRC. The mechanism of transport of dioxin into the EDA is not known. In fact, at the time of sampling, it was not known if any dioxin was present or had ever been present in the soils of the EDA sampling areas. It was known that (1) dioxin had been found in the EDA sewers and creeks and (2) analysis of soil borings taken around the perimeter of Ring II did not indicate the presence of dioxin. Based on anecdotal information, it was theorized that material may have been taken from the Canal and used to fill in low-lying residential areas. If this were true, and the fill did contain dioxin, then this may have been a mechanism of transport.

The selection of the hot spot size was based on the intent of the study, the possible fill transport mechanism, and the habitability study schedule. A much smaller target hot spot size would have greatly increased the number of samples required. A primary consideration in the schedule was the laboratory capacity; a significantly larger number of samples could have delayed the study results and the overall habitability study schedule. The number of sampling points required is directly proportional to the area of the target hot spot. To have the same probability of detecting a hot spot one-fourth the area of the target size used in the study, four times as many samples would have been required (approximately 10,000). The sampling was initiated in November 1986, and the final Quality Assurance (QA) of the analytical results was not completed until March 1988.

COMMENTS: What is the justification for assuming that fill dirt would be uniformly applied to all surface areas of a lot? (Dr. Michael Stoline--Written Preliminary Comments, pp. 4, 8.)

What is recommended if the assumption that fill was uniformly applied over an entire lot cannot be made? (Dr. Michael Stoline--Written Preliminary Comments, p. 4.)

RESPONSE: This was not specifically assumed. If a lot was contaminated, all that was assumed was that the contamination would be above the 1.0-ppb level of concern and that these levels would be reliably detected.

6.1.3 Tilting of the Sampling Grid

COMMENT: What was the reason for the seemingly arbitrary selection of 13 degrees for tilting of the sampling grid? (Dr. Janick Artiola--Written Preliminary Comments, p. 2.)

RESPONSE: An offset rotation of the sampling grid with respect to the predominantly north-south, east-west layout of the streets was chosen to avoid having entire rows or columns of the grid overlaying a street or a set of houses. The offset was an arbitrarily chosen prime number. A prime number was used because it would be less likely to have a submultiple that would interact with the street layout.

6.1.4 Statistical Design

COMMENT: How does the statistical design handle large numbers of non-detect samples? (Dr. Janick Artiola--Written Preliminary Comments, p. 8.)

RESPONSE: The sampling design for this study is based on the size of the locally contaminated area it is designed to detect. The probability of detecting the contamination depends only on the grid size (assuming that a sample taken from a locally contaminated area will contain detectable levels of contamination) and its relationship to the target size of the locally contaminated area.

6.2 METHODS

6.2.1 QAPP Documentation and Implementation

COMMENT: How were the training and qualifications of all field and supervisory personnel checked? Was there a specific review of all subcontracting personnel made by the major contractor as part of the QAPP? (Dr. Janick Artiola--Written Preliminary Comments, p.2.)

RESPONSE: The resumes of personnel from associate firms were checked, particularly for staff with training in the required level of protection and with training or experience in soil sampling.

COMMENT: The QAPP does not give guidelines for the definition of the sod layer or mention the necessary presence of properly trained personnel able to make such separation. Clearly, the use of trained soil scientists during sample collection would have been recommended. (Dr. Janick Artiola--Written Preliminary Comments, p. 3.)

RESPONSE: We assumed that a precise separation of the sod layer was not needed for the purposes of the dioxin study since the sampling technique followed the standard protocol used by Region II for dioxin sampling in residential surface soil. In this sampling technique, the sod layer is removed by cutting the sod layer vegetation (or live plant tissue) and lifting. If there was no sod layer at the sample location, the surface soil was sampled. This approach was taken after lengthy discussion with the CDC and ATSDR.

COMMENT: The EPA acceptance windows for the Performance Evaluation (PE) samples should have been included in the QAPP in a more explicit format. At a concentration of 1.0 ppb, the PE sample analysis results must fall within the range of 0.40 to 1.3 ppb (99 percent). According to Table 6-3 in Volume IV, there are at least two values that appear to fall outside of this range. It is not clear if the PE and other samples were reanalyzed, which appears to be the requirement according to Appendix E of the QAPP. The upper value of the range for the 1.2-ppb target was 2.1, which is 64 percent higher than the target value. The range for acceptable analysis of the PE samples was difficult to find. (Dr. Joan Daisey--Written Preliminary Comments, pp. 1, 2, 5.)

RESPONSE: The criteria for the PE sample results are advisory. Table R-1 of Appendix R summarizes the CLP QC criteria for dioxin analysis.

COMMENTS: Some pages are missing from the beginning of Appendix C. The revisions to the QAPP do not include any corrections. (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

In general, the QAPP and revisions to the QAPP were not as well written and organized as they might have been. The criteria for the QA/QC plan should have been detailed explicitly in a table in an appropriate section. Some of the figures in the original QAPP, e.g., A-5, were missing; others were mislabeled. Certain things are still not clear even after reading all three documents; e.g., was the form shown in Figure A-11 of the original QAPP used for the November/December 1986 sampling? (Dr. Joan Daisey--Written Preliminary Comments, p. 5.)

The documentation of this study is not as well organized or as clear as it should be. It is essential that what was done be clearly and completely documented. The QAPP documents, in particular, should be revised and edited. (Dr. Joan Daisey--Written Preliminary Comments, p. 10.)

The QAPP and revised QAPP documents are difficult to understand and follow. The QAPP should be more "user-friendly." Some guide to the use of the documents is recommended. (Dr. Joan Daisey--Peer Review Meeting Comments, June 20, 1988.)

RESPONSE: It was determined that an incomplete copy of the QAPP had been provided to Dr. Daisey, and a corrected copy was supplied to her.

The QAPP for the soil assessment for 2,3,7,8-TCDD was difficult to follow for two primary reasons:

1. The document was revised during implementation to correctly reflect the changes in the sample homogenization

procedure. Only the changed portions were included in the revised version.

2. The field sampling effort was designed and implemented by CH2M HILL and the laboratory analysis was conducted through the EPA CLP. The appropriate portions of the CLP User's Guide and SOP were included in the QAPP as appendices and were not paraphrased and integrated into the main body of the QAPP. This may have caused some confusion; however, the authors of the QAPP felt it inappropriate to reword or paraphrase the CLP documents.

To make the QAPP more user-friendly, a guide to the use and organization of the QAPP has been prepared that will be inserted behind the title page of each future copy of the QAPP. This guide is provided in Appendix R.

6.2.2 Chemistry

COMMENT: The statistical operating characteristics of the analytical procedure should be provided. The available information is insufficient to determine whether the analytic procedure would be able to reliably detect a concentration of 1.0 ppb and distinguish it from a lower concentration. (Dr. David Schoenfeld--Written Preliminary Comments, p. 1.)

RESPONSE: A performance evaluation study was conducted by EMSL-LV on the CLP analytical method for the analysis of 2,3,7,8-TCDD in soils and sediments. The results of this study indicated that the precision of the method can be characterized by a percent relative standard deviation (RSD) of 7.4 percent for fortified field blanks, and 12.6 to 23.1 percent for PE samples. The study concluded that little, if any, bias exists. Qualitatively, the method of performance is characterized by a false positive rate of 1 to 4 percent and a false negative rate of 2 to 3 percent at a concentration of 0.8 to 1.5 ppb. The report on this performance evaluation is provided in Appendix S.

6.2.3 Numbering of Samples

COMMENT: It is not clear how the PE samples were numbered. Were these samples given a random number that looked like the sample numbers for the Love Canal samples? Could the analyst identify a PE sample from the number? (Dr. Joan Daisey--Written Preliminary Comments, p. 2.)

RESPONSE: PE samples were numbered so that the analyst could not distinguish them from field samples.

COMMENT: Sample numbering is not clear from the QAPP documents or Volume IV. How many numbers were associated with each collected sample? How well were the numbers on the different forms and labels cross-checked? A table listing all documents, labels, tags, etc., generated for each sample would have been very helpful. (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

RESPONSE: Each sample was assigned one sample number. The forms and labels were computer-generated and cross-checked as part of the sample management program. The documents, labels, and tags are described in the QAPP.

6.2.4 Data Review

COMMENT: Appendix C of Volume IV states that all analytical data were evaluated by Region II analysts/reviewers trained in GC/MS analysis and having specialized knowledge of dioxin analysis. This document is ambiguous. A clearer statement of exactly what was reviewed and an explicit statement that the analyses met or did not meet the criteria should have been included. (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

RESPONSE: Analytical results for each sample and batch of samples were reviewed using a checklist of criteria from the CLP SOP, which is provided in Appendix C of Volume IV.

6.2.5 Audits

COMMENT: It is not clear in Appendix C whether the CLP laboratories were audited prior to any Love Canal sample analysis. (Dr. Joan Daisey--Written Preliminary Comments, p. 3.)

RESPONSE: Laboratories analyzing dioxin under the CLP contract are audited before samples are received and then annually thereafter. Eagle Picher, KCSI, and TMS were audited before they received samples. ETC had participated in the CLP program under a previous contract and, therefore, their performance had been audited previously. ETC was audited again in March 1987, approximately 2 months after it received samples. ECAL analyzed dioxin samples under a special services contract and had been audited by EPA Region II prior to receipt of samples for other dioxin work. (See p. 2 of Appendix C, Volume IV.)

COMMENT: The major substantive change in the QAPP was the sample homogenization method. The change was reasonable; however, since there was no field audit during the May 1987 field sampling, there is no information on whether the 2-minute mixing protocol was followed. (Dr. Joan Daisey--Written Preliminary Comments, p. 7.)

RESPONSE: The modified homogenization procedure (hand-mixing) that was used and audited at the homogenization laboratory was also used in the field. Page A-14 of Appendix A of the revised dioxin QAPP states:

"5. Mix for 2 minutes with stainless steel spoon."

While no formal audit was conducted in May 1987, a form outlining the 11-step procedure to be used for collection and homogenization of each sample was signed and dated by the sample collector after each sample was collected and homogenized.

6.3 RESULTS

6.3.1 Moving of Sampling Points

COMMENT: Why were some sampling points located beyond the 35-foot limit rather than simply dropping the node, as suggested in the QAPP documents? (Dr. Michael R. Stoline--Written Preliminary Comments, pp. 6, 8.)

RESPONSE: Less than 4 percent of the samples collected were located outside the 35-foot limit as a result of field activities that were not detected until post- fieldwork QC review was completed. The original grid nodes associated with these samples were resampled where possible. The results of both analyses were included in Volume IV.

In most cases, samples tied to grid nodes that had to be moved more than 35 feet because of unsampleable surfaces (i.e., pavement, house, etc.) should have instead been dropped according to the plan. However, in some cases a point was moved and sampled to satisfy the two-sample-per-lot criterion. The alternative was to use an arbitrarily located sampling point to satisfy the two-sample-per-lot criterion for that lot. It was felt at the time that it was better to have a point tied to a grid node than arbitrarily located. As shown in Table 6-1, 90 points were moved further than 35 feet from the associated grid node, and 63 of these were satisfactorily resampled at the grid node. For the remaining 27, it was not possible to sample within 35 feet of the grid node for the following reasons:

1. Driveways, garages, or ponding areas on residential lots were encountered at the designated grid node location. The point was moved to the nearest soil surface which, in some cases, was more than 35 feet from the grid node.

2. The designated grid node was located on a rooftop. According to the sample design, such nodes were to be moved 5 feet from the structure. In some cases, this was more than 35 feet from the designated grid node location.

Table 6-1

DISTANCE ACTUAL SAMPLING POINTS WERE MOVED FROM GRID NODES
SOIL ASSESSMENT--2,3,7,8-TCDD

Distance Moved	Number of Sites
Not Moved	567
0 to 5 feet	939
>5 to 15 feet	429
>15 to 25 feet	260
>25 to 35 feet	125
>35 feet	90
TOTAL SITES	2,410
Number of sites moved >35 feet that were resampled	63
Number of sites moved >35 feet that were not resampled	27

3. The grid node was located on paved areas such as roadways or parking lots. The point was moved to the nearest soil surface which, in some cases, was more than 35 feet from the grid node. In most of these cases the sampling point was moved to the yard of a property where only one grid node was located; this was done to provide the second sampling point to fulfill the two-sample-per-lot criterion.

6.3.2 Modifications During Implementation

COMMENT: A short discussion on any changes or modifications that may have been made in the course of the implementation of the QAPP is suggested. (Dr. Janick Artiola--Written Preliminary Comments, p. 4.)

RESPONSE: All changes are addressed in the revised QAPP. The only change during implementation was the change in the homogenization procedure, which is discussed on page 5-1 of Volume IV.

COMMENTS: Effects of the sampling month, rainfall, and changes in the sampling plan should have been evaluated. The original schedule that called for all samples to be obtained in November/December 1986 was modified, resulting in samples being collected in November/December 1986 and May and July 1987. Reasons for this modification are not adequately explained or considered in the analysis. Why was the month of June skipped? Was there a marked difference in rainfall over these months, such that dioxin might have been dispersed more in one of the months? More discussion should be presented on the reasons for and circumstances surrounding this change in the sampling schedule, and some interpretation should be made of whether the change had any potential impact on the results obtained. (Dr. Carl Shy--Written Preliminary Comments, pp. 3-4, 6, 7.)

The results should be shown by month and by type of sample, e.g., original sample, archive sample, QC sample. Because of the differences in the mixing technique for samples collected in different time periods, the results of the analyses should be displayed separately for the November/December and the May and July samples. (Dr. Carl Shy--Written Preliminary Comments, pp. 3, 5, 7.)

Was there any difference in the proportion of samples with positive dioxin values for the two time periods? (Dr. Carl Shy--Written Preliminary Comments, p. 3.)

A table summarizing the results by concentration by month is preferred. (Dr. Carl Shy--Peer Review Meeting Comments, June 20, 1988.)

Are the trace levels at all associated with month of sampling, homogenization method, or rainfall patterns? (Dr. Carl Shy--Written Preliminary Comments, p. 6.)

RESPONSE: Sampling was stopped from December to May because of inclement weather. As a result, approximately 600 samples remained to be collected. In addition, a QA check of the sample coordinates was made, and it was discovered that several points had been moved more than 35 feet from the original grid node. These grid nodes were resampled along with the remaining 600 points during the sampling conducted in May. After a QA of the sample coordinates taken in May, a few points still had been moved more than the 35-foot limit. This, coupled with the fact that more properties were now available for sampling [Love Canal Area Revitalization Agency (LCARA) had purchased more properties], led the TRC to a decision to collect additional samples during July.

It was not expected that these changes would affect the results, since the solubility of dioxin in water has been estimated to be approximately 32 parts per trillion (U.S. EPA, 1987) and dioxin binds tightly to soil organic matter. These physical characteristics suggest that dioxin that has been in the soil for several years should not be significantly affected by these factors.

Table 6-2 shows the results, by month collected, of the dioxin samples. As can be seen, there is no apparent association of higher concentrations with the time of year that the sample was collected. Therefore, it can be inferred that the weather or the different seasons did not affect the dioxin results.

6.3.3 Statistical Interpretation

COMMENT: An unanswered question remains: Was the 95 percent probability of detect lowered by moving some of the sample points? (Dr. Janick Artiola--Written Preliminary Comments, p. 8.)

RESPONSE: The sampling program was designed to have a 95 percent probability of detecting a locally contaminated elliptical area approximately 126 feet long by 66 feet wide. This ellipse has an area of approximately 6,500 square feet, which is the median lot size in the EDA.

During the implementation of this sampling plan, several sample locations had to be moved because of the infeasibility of sampling the assigned location (pavement, structure, etc.).

An estimate of the retrospective probability of detecting a locally contaminated area of 6,500 square feet was developed by using Monte Carlo Simulation. The coordinates of the EDA neighborhood boundaries and the points sampled were used as a data base by the simulation. The computer program estimated the probability of detecting a locally contaminated area by generating a simulated locally contaminated area and placing it at a random location and orientation on the map of the EDA. If the simulated area was within the EDA and contained a sampled location, it was counted as a hit. If the simulated area was within the EDA but did not contain a sampled location, it was counted as a miss.

The ratio of hits to misses is an empirical estimate of the probability of detecting a contaminated area. This estimate has a slight high bias because 14 of the 2,274 points sampled had no valid results. The estimate has a low bias because the EDA

Table 6-2

SUMMARY OF SAMPLE RESULTS BY SAMPLING MONTH
SOIL ASSESSMENT--2,3,7,8-TCDD

Concentration Range (PPB)	Sampling Locations With Highest Result In Concentration Range					Total Results Using All Reported Concentrations for Each Location				
	Nov	Dec	May	Jul	Total	Nov	Dec	May	Jul	Total
ND	645	934	594	38	2,211	752	1,034	629	39	2,454
<0.2	16	20	4	0	40	22	22	5	0	49
≧ 0.2 and<0.4	2	1	2	0	5	2	1	2	0	5
≧ 0.4 and<0.6	0	0	0	0	0	0	0	0	0	0
≧ 0.6 and<0.8	0	0	2	0	2	1	0	2	0	3
≧ 0.8 and<1.0	1	0	0	0	1	1	0	0	0	1
≧ 1.0	0	0	1	0	1	0	0	5	0	5
	664	955	603	38	2,260	778	1,057	643	39	2,517
Did Not Pass QC	8	2	4	0	14					
Total Samples Collected	672	957	607	38	2,274					

contained areas of 6,500 square feet or larger that did not have accessible soil (i.e., the area was paved) but were not removed from the simulated EDA. The estimated probability of detecting the target-size locally contaminated area is 88 percent. The details of the simulation can be found in Appendix T.

COMMENTS: Those charged with making the habitability decisions should at least be aware of how the probability of detecting a hot spot changes when the size of the hot spot is only a fraction of the size of a median EDA residential lot. (Dr. Michael Stoline--Preliminary Written Comments, p. 4.)

Emphasize that any dioxin-contaminated fill areas smaller than the size of a median-size lot have a much less than 95 percent chance of being detected with the statistical sampling design used in this study. (Dr. Janick Artiola--Written Preliminary Comments, p. 8.)

What is the probability that the sampling plan would detect dioxin in an area one-third the size of a lot? (Dr. Michael R. Stoline--Written Preliminary Comments, p. 4.)

RESPONSE: Figure 6-1 shows the relationship between ellipse dimensions, the grid size, and the probability of finding (or detecting) the ellipse. The variables shown in the figure are the following:

L = Length of the semi-major axis of the ellipse

G = Grid size

S = Length of the minor axis divided by the length of the major axis of the ellipse

B = 1 minus the probability of detecting the target-size contaminated area

The paragraphs below describe the calculation used in the sampling design and the subsequent calculation of the retrospective probability of finding a target hot spot one-third the size of the design target size.

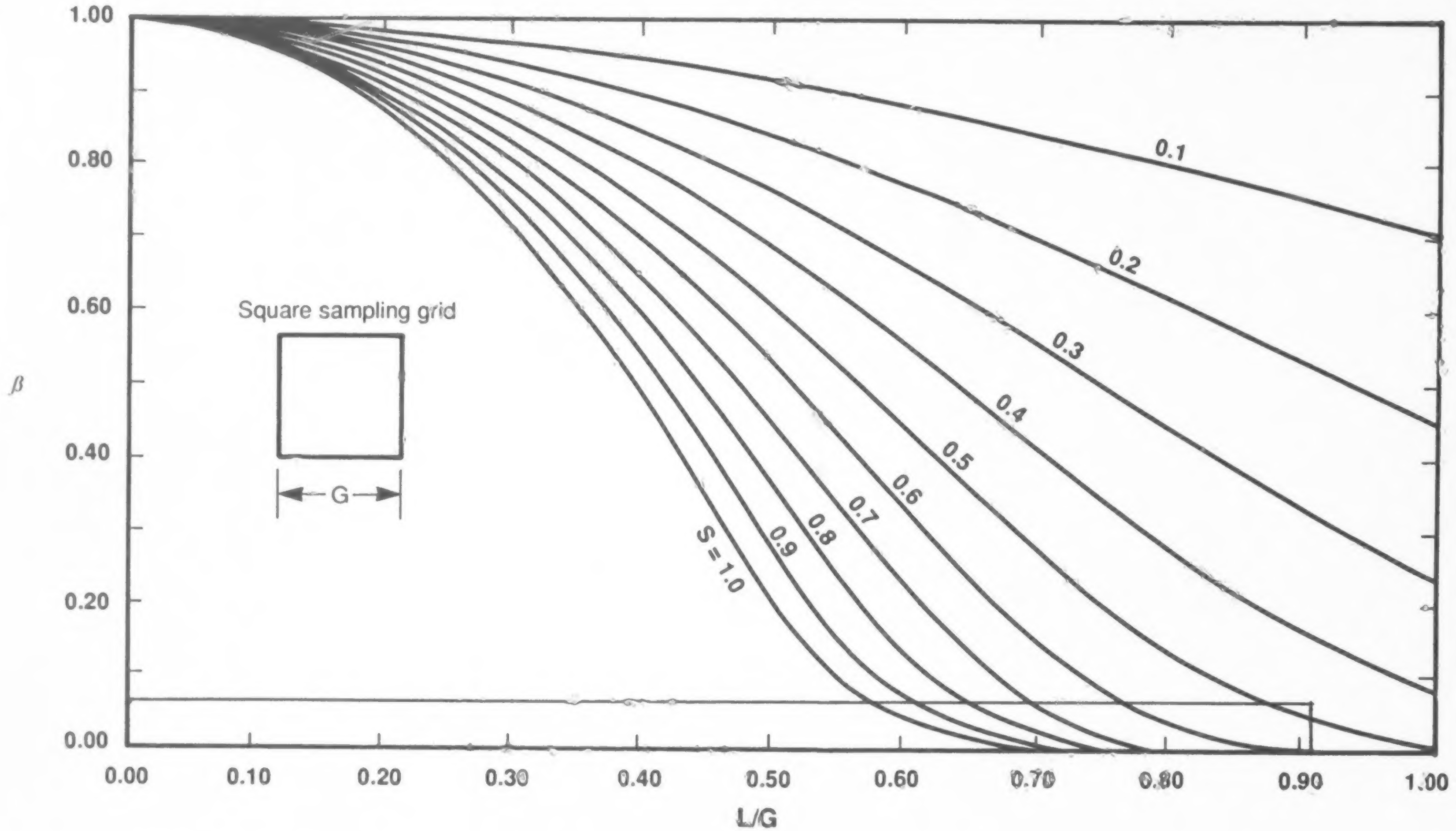

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Figure 6-1
SOIL ASSESSMENT--2, 3, 7, 8,-TCDD
DESIGN OF SAMPLING GRID

Design: For the design, an ellipse with an area of approximately 6,500 square feet was used. (This ellipse was selected to represent the median size of a residential lot in the EDA.) A design criterion of 95 percent probability of detecting the target-size ellipse was also used. The variables had the following values:

L = 63 feet

G = ? (object of calculation)

S = 0.52 (= 66/126)

B = 0.05 (= 1 - 95%)

As shown in Figure 6-1, with the above values assigned for the variables, the L/G ratio must be about 0.91. That is, the grid size (length) must be about 10 percent longer than the length of the semi-major axis. The semi-major axis of the target ellipse is 63 feet; thus, a grid size of 69 feet was selected.

An area one-third that of a median-size lot: For an area one-third that of the target size, the length of the ellipse is approximately 58 percent of the original ellipse (square root of 1/3 = 0.58). The variables used in the figure for this determination are as follows:

L = 36.5 feet (0.58 * 63)

G = 69 feet

L/G = 0.53

S = 0.52 (proportion of the ellipse remains constant)

B = ? (object of calculation)

As shown in Figure 6-2, the value of B for the above-assigned values is about 0.55, which makes the probability of detecting a target area this size approximately 45 percent (1 minus 0.55).

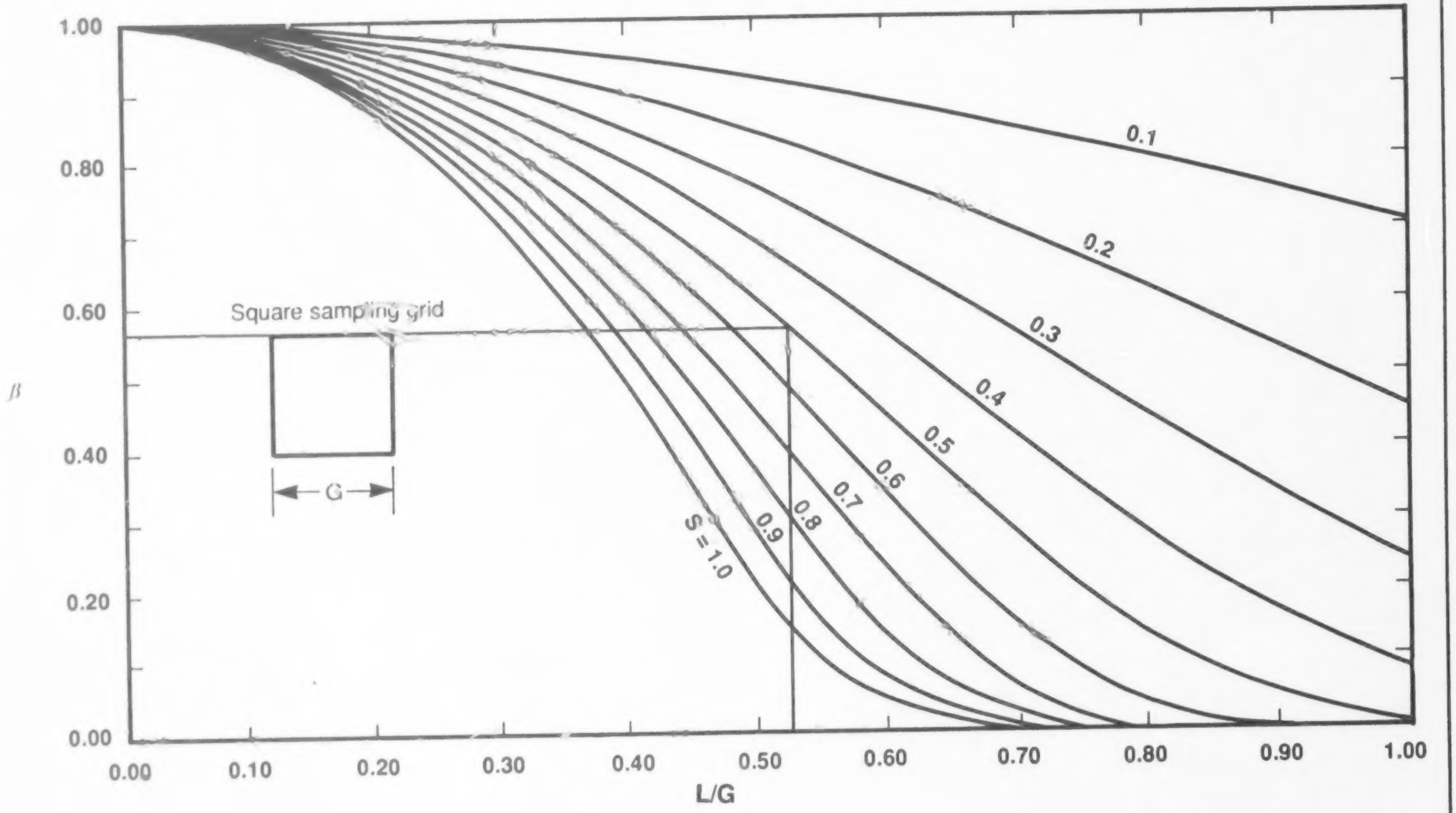

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Figure 6-2
SOIL ASSESSMENT -- 2,3,7,8-TCDD
PROBABILITY OF DETECTING LOCALLY CONTAMINATED AREA
ONE THIRD THE SIZE OF THE TARGET AREA (1 MINUS B = 45%)

6.3.4 Interpretation of the Results

COMMENT: The reader should be given more details about the circumstances, if any are known, that might account for this elevated dioxin concentration. Is there any evidence that fill dirt from the Canal was spread on this site? Will deeper soil samples be obtained from this site? (Dr. Carl Shy--Written Preliminary Comments, p. 6.)

RESPONSE: No visual evidence of a source was found. A summary of the results of an effort by NYSDOH to research the site is attached (Appendix U). Additional sampling, which has included soil samples taken at depths varying from 2 inches to 12 inches, has been performed, and the sampling results are summarized in Appendix V.

COMMENT: An underlying assumption of the study was that the recoveries of the MS samples would reflect the recoveries of the EDA samples. If the recoveries of the EDA samples were actually lower, then there could be more sites that should be classified as equal to or greater than 1.0 ppb. Neither the QAPP nor Volume IV adequately addresses the issue of how the recoveries and associated uncertainties apply to detect values in the range of 0.5 to 0.9 ppb. The issue of the recovery of 2,3,7,8-TCDD from the EDA samples is a remaining uncertainty. (Dr. Joan Daisey--Written Preliminary Comments, pp. 8, 9.)

RESPONSE: Table 6-3 lists the MS recoveries associated with samples that had a dioxin concentration between 0.5 ppb and 1.0 ppb. Only four analytical results were in this range. Two of those results had high MS recoveries (1.2 ppb versus 1.0 ppb) indicating that estimated values for that batch, if biased, were more likely to be biased high than low. The other two concentration values were associated with the same sample. For the first analysis of this sample, the result was a 0.63-ppb concentration with a 0.95-ppb MS result. A followup analysis by high resolution mass spectrometry, which was requested, indicated a sample concentration of 0.92 ppb; since this was a special followup confirmatory analysis, an additional MS was not analyzed.

Table 6-3

SUMMARY OF CONCENTRATIONS MEASURED FROM 0.5 ppb to 1.0 ppb AND THEIR ASSOCIATED MATRIX SPIKE RESULTS
SOIL ASSESSMENT--2,3,7,8-TCDD

Station No.	DB No.	Type of Sample	Initial Result (ppb)	Initial Matrix Spike Result (ppb)	Rerun Result (ppb)	Rerun Matrix Spike Result (ppb)
1932	030110	Original	0.62	1.2	N/A	N/A
1936	030108	Original	0.61	1.2	ND (MPC=0.04)	0.90
5234	016309	Original	Rejected	Rejected	ND (MPC=0.36)	0.95
					ND (MPC=0.19)	0.91
	026413	Archive	0.63[a]	0.95	0.92[a]	N/A

---

[a] Analyzed by high resolution MS technique

COMMENT: The sampling plan is based on the assumption that there was no movement of dioxin from the Love Canal by water transport, e.g., flooding and/or rainfall runoff. Since the land is fairly flat, this seems reasonable. However, the clustering of the detects in the contiguous sectors 6, 7, 8, and 9 suggests the possibility of water transport. Has this been considered? How would this affect the validity of the statistically based sampling plan? (Dr. Joan Daisey--Written Preliminary Comments, p. 10.)

RESPONSE: The results have been mapped. Given the fact that only one location sampled had dioxin at concentrations above the level of concern and low levels of most of the dioxin detects [relative to the Maximum Possible Concentrations (MPCs) for the non-detects and relative to health concerns], it does not appear that a sophisticated analysis of the detect data is merited.

6.3.5 Additional Information/Discussion Needed

COMMENT: No explanation is given for the statement that the concentration of dioxin in the original sample of the one soil specimen that exceeded 1.0 ppb could not be quantified. It would have been highly desirable to have comparable data for the original and archive samples from this site. (Dr. Carl Shy--Written Preliminary Comments, p. 6.)

RESPONSE: Two analyses of the original sample were rejected because of low internal standard (IS) recoveries (4 percent and 5 percent). The *estimated* values for these sample analyses were 17.5 and 13.4 ppb, respectively. The low IS recovery was accounted for in calculating the sample concentration. The estimated concentrations of 13.4 and 17.5 ppb are in relatively close agreement with the five archive sample results (17.3 to 21.2 ppb).

COMMENT: The report describes retrieval of 279 archive samples but fails to state the basis for selecting the 170 archive samples and 30 associated QC samples that were sent to a new laboratory for QC checks. Both the selection criteria and rationale for these analyses should be stated. (Dr. Carl Shy--Written Preliminary Comments, p. 5.)

RESPONSE: A QA review of the first few batches of samples analyzed in the program indicated that a laboratory was having trouble successfully analyzing the samples. The EPA QA officer asked the laboratory to rerun the samples. In addition, the QA officer decided to perform an additional QC check on the laboratories participating in the study.

It was determined that the 60 archive samples associated with the sample batches that were rejected because of failed PEs should be analyzed by a separate laboratory. Since, at that time, most of the sample results were non-detects, an effort was made to improve the chance for detects in this QC check so that a QC comparison could be made. Therefore, 60 additional archive samples selected from Sampling Area 1 were sent for analysis. (Pilot studies had shown that a higher frequency of detectable levels of soil LCICs occurred in this area, and it was therefore assumed that the probability of detecting dioxin in samples from this area may be higher.) In addition, 50 archive samples were selected randomly to provide further comparison results. Overall, a total of 170 archive samples were equally distributed into 10 coolers and were packaged and shipped in the same manner as regular samples (i.e., each batch consisted of 16 field samples, 1 field replicate, 1 Shipping and Storage Blank (SSB), 1 MS, and 1 PE).

COMMENT: Did the difference in homogenization procedures result in different sample rejection rates over the two time periods? (Dr. Carl Shy--Written Preliminary Comments, p. 3.)

RESPONSE: Sample rejections were based on various factors that were not related to the homogeneity of the sample but were instead related to laboratory performance. (Many of the sample analyses were rejected because of failed QC sample analyses; most of these samples were reanalyzed.)

COMMENT: It would be useful to document the reasons for owner refusal to participate in the sampling study. (Dr. Michael Stoline--Written Preliminary Comments, p. 8.)

RESPONSE: Reasons for homeowner refusals for each of the environmental assessment programs are contained in Appendix D.

COMMENT: The data on the results (recoveries) of the MS analyses should be presented in Volume IV. (Dr. Joan Daisey--Written Preliminary Comments, p. 2.)

RESPONSE: The range and median of the results of the MS analyses are given in Volume IV, p. 6-6.

COMMENT: There is insufficient information on the nature of the soil used for the MS and PE samples. What was the source of the soil? What were the criteria used to determine that it was comparable to the soil from the Love Canal area? Were soil particle size distributions and moisture contents similar to the real samples? Were the appearances of the MS and PE samples similar to those of the real samples or could the analyst identify the PE sample by appearance? (Dr. Joan Daisey--Written Preliminary Comments, p. 2.)

RESPONSE: PE samples were obtained from EMSL-LV and NUS through EPA Region II. The PE samples obtained from EMSL-LV were spiked sand or clay samples. The PE samples from NUS were native soils from an EPA Region II dioxin site in the Newark, New Jersey, area. For the MS samples, Soil Conservation Service (SCS) charts were used to locate soil similar to EDA soil in Ipswich, Massachusetts, since the blanks were being prepared there. The SCS groups soils as similar based on distinctive soil relief and drainage. The soil physically resembled EDA soil. Information on particle size distribution and moisture content of the EDA soils was not available to further match the Ipswich soil. Analyses were conducted on representative samples of the blank soil, and the results indicated no dioxin.

COMMENT: It is not clear why the discrepancies between the plotted sampling point lot locations and the field-observed sampling point lot locations occurred. This should be clarified. (Dr. Joan Daisey--Written Preliminary Comments, p. 4.)

RESPONSE: The sampling points were surveyed to a permanent U.S. Geological Survey benchmark, and the base map was not. The base map was created using aerial photographs, was field-checked, but was not verified by comparison with ground-truth. The property boundaries were based on tax maps obtained from the City of Niagara Falls.

6.4 OTHER

6.4.1 Issues Related to the Habitability Decision

COMMENT: We must revise our previous assumptions to allow for the existence of several hot spots with the same amount of surface area as the one that was discovered. (Dr. David Schoenfeld--Written Preliminary Comments, p. 2.)

RESPONSE: The contaminated area that was found during the dioxin soil assessment is estimated to be less than 5 feet in radius; this is based on subsequent sampling of the area. One hypothesis is that this area was contaminated by an ascribable cause. If this is the case, the type of design assumptions that were used in the assessment sampling may be inappropriate for a contaminated area of this size.

However, if an ascribable cause is not found and the contaminated area is assumed to be representative of a random occurrence in the EDA, an estimate of the maximum probable frequency of randomly occurring 5-foot-or-less-radius hot spots can be made.

If contaminated areas of 2 feet in radius are distributed randomly throughout the EDA and it is assumed that the 2,260 samples collected (with valid analytical results) were located randomly (not unreasonable since the hypothesized contaminated area is so small relative to the sample grid design), then the point estimate of the probability of locating such an area is 1 in 2,260 or 0.0004425.

The 95 percent upper confidence bound on this estimate is obtained from:

$$L=((X+1)*F(0.05,df1,df2))/(n-x+(x+1)*F(0.05,df1,df2))$$

where $df1=2*(X+1)=4$
$df2=2*(N-X)=4518$

$X=1, N=2260, F(0.05,4,4518)=2.37$

and $L=0.002094$. (Zar, 1984, p. 378)

$N=0.002094*2260=4.7$ (or about 5 hits for
2,260 samples)

This estimate indicates that if the contaminated areas are randomly distributed over the EDA, another 2,260 samples would have a 95 percent probability of finding fewer than five such areas.

COMMENT: If the EDA is declared habitable, will the new dwellers be relegated to keeping their yard activities within the top 2 inches? (Dr. Janick Artiola--Written Preliminary Comments, p. 9.)

RESPONSE: The study design called for measurements of dioxin in the top 2 inches of soil to determine if dioxin was present above 1.0 ppb. For the purposes of this study, and consistent with the CDC level of concern, it was assumed that activities would not be restricted to the top 2 inches of soil if the levels of dioxin were below 1.0 ppb.

COMMENT: The discussion section is inadequate and unsatisfactory. No effort is made to interpret for the reader the meaning and significance of the distribution and levels of positive dioxin soil samples. Are these less-than-1.0-ppb samples a random finding typical of an uncontaminated neighborhood? Do they represent traces of dioxin that were present at higher concentrations? Are the trace levels at all associated with sample collection teams? (Dr. Carl Shy--Written Preliminary Comments, pp. 6-8).

RESPONSE: The data are not available to determine whether the less-than-1.0-ppb samples represent typical random findings. This study was not designed to address this issue but rather to compare the results to the CDC 1.0-ppb level of concern.

COMMENTS: A conclusion is needed: Do the authors believe that the results suggest no problem with dioxin in soil? (Dr. Carl Shy--Written Preliminary Comments, pp. 6-8.)

How safe is the EDA for children playing? How safe is the EDA for gardening activities? An approach to answering these questions is to estimate the median-size play area for a child in the EDA and to estimate the median-size garden area for a typical EDA resident. Assume that fill dirt, if used, would be uniformly spread over the typical play area or typical garden area, and determine the probability of detecting hot spots of both of these sizes. How habitable is an area that contains subareas, however small and isolated, that are known to be contaminated or known to have been contaminated? What does this say about the quality of life attainable? (Dr. Michael Stoline--Written Preliminary Comments, pp. 4, 10, 11.)

The results of this study should be explained in terms that can be easily understood. (Dr. David Schoenfeld--Peer Review Meeting Comments, June 20, 1988).

RESPONSE: Appendices P and Q summarize the assumptions and rationale for the 1.0-ppb level of concern for dioxin in residential soils. The level of concern assumes uniform and average contamination of soil at 1.0 ppb. The public health risk associated with exposure to soil is a complex combination of the level of contamination, the size of a contaminated area, the type of use of the area, the length of time persons are using the area, and the age of persons using the area.

The risk associated with exposure to a small area of elevated contamination decreases as the area gets smaller. The contaminated area that was found in the EDA had dioxin up to 17.0 to 35.0 ppb in an area estimated to be less than 5 feet in radius. Such an area (80 square feet) comprises about 1 percent of the area of a median-size lot in the EDA. Thus, long-term exposure to soil from a lot that might have such an area of contamination poses a lower risk than if the entire lot were contaminated at 1.0 ppb. If the contaminated area were the focus of a child's play area or a home garden, the dioxin exposure from soil may be higher than if the lot were uniformly contaminated at 1.0 ppb. However, the chance that such a contaminated area exists and would be the focus of such activities is quite small.

At the request of EPA Region II, ATSDR reviewed the results of dioxin sampling and prepared a health consultation. This consultation is presented in Appendix W and concludes:

- The investigation for 2,3,7,8-TCDD contamination is adequate to define the potential exposure of humans posed by the chemical's presence in the area.
- There is no widespread 2,3,7,8-TCDD contamination in the surface soil within the EDA that might present any threat to human health for the residents.

COMMENT: Clearly discuss the chances of exposure to dioxin contamination as a function of target hot spot size and sample depth. (Consensus Comment--Peer Review Meeting, June 20, 1988.)

RESPONSE: As discussed in Section 6.3.3, the likelihood of detecting a hot spot decreases with the size of the hot spot. Figures 6-1 and 6-2 showed the relationship between hot spot size and the probability of detection. Basically, the smaller the hot spot the less likely it will be to find it with the same-size sampling grid. However, it should be noted that the risk associated with exposure to a hot spot also decreases with the size of the hot spot. This is because the probability that a person will interact with the hot spot decreases with the size of the hot spot.

Only the top 2 inches of soil were sampled. The top 2 inches were selected to sample the most accessible soil; this was based on EPA Region II standard procedures for dioxin sampling in residential soil. The followup depth sampling at the location with a concentration above the level of concern indicated that the concentration of dioxin decreased with depth; this would support the decision to sample the top 2 inches if it were assumed that the mode of transport at the hit location was the only potential mode of transport. However, because none of the potential modes of transport have been eliminated, no conclusions can be drawn about the concentration of dioxin at depths greater than 2 inches.

COMMENT: Discuss the chronic exposure conditions assumed by the CDC in the derivation of the 1.0-ppb level of concern, as these relate to the types of exposures that might be expected to occur in the EDA. (Consensus Comment--Peer Review Meeting, June 20, 1988.)

RESPONSE: The assumptions used by the CDC in deriving the 1.0-ppb level of concern for dioxin in residential soils are summarized in Appendix Q. The 1.0-ppb level of concern and assumptions used to arrive at this level of concern are considered to be applicable to residential areas in general and, therefore, applicable to those types of exposure that might be expected to occur in the EDA. Also, the CDC and the ATSDR were consulted and concurred on the study design.

6.4.2 Documentation

COMMENT: A large body of data sheets, notebooks, analytical information, etc., has been generated in this study. What is the ultimate fate of this documentation? The habitability criteria states that all of the environmental data from these studies will be made available to the general public and the scientific community for analysis and interpretation. (Dr. Joan Daisey--Written Preliminary Comments, p. 10.)

RESPONSE: This information will be stored by EPA and will be available to the public through an FOIA request to EPA Region II.

REFERENCES

CH2M HILL. 1986. *Love Canal Dioxin Soil Sampling Study Quality Assurance Project Plan.*

CH2M HILL. 1987a. *Love Canal Full-Scale Air Sampling Study Quality Assurance Project Plan.*

CH2M HILL. 1987b. *Love Canal Habitability Study-- Soil Sample Collection and Preparation Quality Assurance Project Plan (Final Revised Version).*

CH2M HILL. 1987c. *Love Canal Habitability Study--Soil Sample Laboratory Analysis Quality Assurance Project Plan.*

CH2M HILL. 1987d. *Pilot Study for Love Canal EDA Habitability Study. (Vol. I and II)*

CH2M HILL. 1987e. *Revisions to Love Canal Dioxin Soil Sampling Study Quality Assurance Project Plan.*

CH2M HILL. 1987f. *Summary of Responses to The Peer Review of The Pilot Study For The Love Canal EDA Habitability Study. (Vol. I and II)*

CH2M HILL. 1988a. *Love Canal Emergency Declaration Area Habitability Study, Vol. II: Air Assessment--Indicator Chemicals.*

CH2M HILL. 1988b. *Love Canal Emergency Declaration Area Habitability Study, Vol. III: Soil Assessment-- Indicator Chemicals.*

CH2M HILL. 1988c. *Love Canal Emergency Declaration Area Habitability Study. Vol. IV: Soil Assessment--2,3,7,8-TCDD.*

Gilbert, Richard O. 1987. *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold Company, New York.

ICAIR and CH2M HILL. 1988. *Love Canal Emergency Declaration Area Habitability Study, Vol. I: Introduction and Decision-Making Documentation.*

Kimbrough, Renate D.; Henry Falk; Paul Stehr; and George Fries. 1984. "Health Implications of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Contamination in Residential Soil." *Journal of Toxicology and Environmental Health*, 14, pp. 47-93.

NYSDOH and DHHS/CDC. 1986. *Love Canal Emergency Declaration Area; Proposed Habitability Study.*

U.S. EPA. 1987. *The National Dioxin Study.*

Zar, Jerrold H. 1984. *Biostatistical Analysis.* Prentice Hall, Englewood Cliffs, New Jersey.

APPENDIX A
Final Summary of Modifications to TAGA Procedures, April 15, 1988

Air Assessment--Indicator Chemicals

Prepared by

U.S. EPA Environmental Response Branch
Environmental Response Team
Edison, New Jersey

Final Summary of Modifications to TAGA Procedures Used During the Love Canal Full-Scale Air Sampling Study

April 15, 1988

FROM: Thomas H. Pritchett
ERT QA/QC Coordinator (Love Canal)
Environmental Response Branch
U.S. Environmental Protection Agency

INTRODUCTION

From the period from July 1987 to December 1987 the Environmental Response Teams (ERT's) mobile mass spectrometer / mass spectrometer (the TAGA) conducted indoor air analyses at Love Canal as part of the overall Love Canal Emergency Declaration Area (EDA) Full Scale Habitability Study. The analyses were performed using the procedures outlined in the Summary of the TAGA Standard Operating and Reporting Procedures (SORP) for the Love Canal Full-Scale Air Sampling Study which was Appendix A of the Love Canal Full-Scale Air Sampling Study Quality Assurance Project Plan (QAPP) prepared by CH2M Hill in July 1987 with the procedural modification outlined below.

The indoor air analyses were performed the ERT's EERU contractor (Enviresponse, Inc.) in Phase 1 of the study and by the ERT's REAC contractor (Roy F. Weston, Inc.) in Phases 2 - 4. Between Phases 1 and 2 of the study the ERT changed its operations assistance contract from the EERU contract to the REAC contract. However, because Roy F. Weston hired for its REAC contract all the old EERU personnel involved in the study, no key personnel were lost during the contract transfer. All changes in key personnel (primarly that of the Sampling Crew Chief) were made by on-site training of the replacement by the replaced personnel. Thus the data quality was never adversely affected by the change in ERT contractors.

MODIFICATIONS TO TAGA ANALYTICAL PROCEDURES

The original TAGA analytical procedures were contained in the Summary Of The TAGA Standard Operating Procedures For The Love Canal Full-Scale Air Sampling Study (SORP), which was Appendix A of the QAPP. At the start of the study this SORP was a set of procedures and reporting formats which had never been tested under a full set of field conditions. Consequently, based upon the actual field experiences and data, several typographic errors in criteria were discovered (e.g., the reversal in the Instrument Startup Checklist of the maximum acceptable temperatures for cryoshells #2 and #3), some procedures were modified and improved after sufficient field data was gathered (e.g., after Phase 1 the changing from a heated Teflon sampling line to unheated Teflon tubing), and several data criteria were modified to reflect lessons learned (e.g., the changing of the ID criteria to be applied to data above the quantitation limit).

Such changes, modifications, and improvements are to be expected whenever "state of the art" analytical methodologies and procedures are first utilized in the field. Because of the time constraints built into the sampling effort, a pilot field trial of new analytical protocols was by-passed for this program and draft procedures were finalized. Had sufficient time been available for either one to two months of full trials at Edison or a practice mobilization, many of these modifications would have been made prior to their being finalized in QAPP.

All such procedural and data criteria modifications were first approved by the ERT QA/QC coordinator prior to their implementation. Also, all such changes were also documented by memorandum to the Love Canal files written by the ERT QA/QC coordinator. These memorandum are included as References in the final report on the air analyses. Copies were also given to the Region II Project Manager, the CH2M Hill Task Manager, and the ERT QA Analytical Operations Director. In addition, the changes which went into effect prior to the start of the Phase 2 analyses were summarized in a memorandum dated September 14, 1987 written by the ERT QA/QC Coordinator to the Region II Project Manager.

These modifications are summarized below in the approximate chronological order of the first application (as documented in the original memorandums to file). In a very few cases ambiguities also occurred between the original memorandum and the more brief description contained in the September 14 summary. The below listing also clarifies these ambiguities.

1) Detection Limit Criteria

During the first mobilization a modification was made to the decision tree used to determine whether an LCIC was detected. This modification was initially made to take into account the artificially high instrument noise levels which were encountered during the first phase of monitoring. It resulted in higher confidence in any reported levels of LCICs detected. The new decision tree was as follows:

> As an initial screen the individual ion pair signal were first compared against the ion pair detection limits (defined by the zero signal plus two times the standard deviation). If any ion pair signal (in ion counts per second) was below its detection limit, then the compound was considered not detected. (This initial screen is the test specified in the QAPP.) However, if all three signals were above their detection limits, then the corresponding concentration values were then computed and the concentration reported by the most sensitive ion pair was then compared against the compound detection limit. The LCIC was not considered to be detected unless the concentration computed from the most sensitive ion pair was above the compound detection limit.

2) The Use of a Single Calibration for Successive QA/QC Analyses

During Phases 1 - 3 two QA/QC analyses, each requiring prior calibrations, were performed successively at the end of alternate days. These analyses were the precision canisters and the detection limit / quantitation limit verifications. The documentation requirements for these analyses implied that separate analyses were required for each. This implied procedure was changed such that the calibration performed for the first analysis could be used in reducing the data for the second analysis provided that the two analyses were performed with no delay between the two. This modification resulted in more efficient utilization of instrument time and had no affect on the data quality.

Starting in Phase 4, three quantitative QA/QC analyses were being performed at the end of every other day. These analyses were a 6 Liter Summa performance evaluation canister analysis, a 16 Liter Summa precision canister analysis, and the detection limit & quantitation limit verification. Past data had shown that by the end of the day the TAGA response factors were stable over a ninety minute time period. Therefore, one calibration was allowed for all three analyses provided that the analyses were completed within ninety minutes. Since the 16 Liter performance evaluation canister analysis and quantitation verification analysis both involved accuracy checks against known spiked concentrations, one of these analyses had to be the last analysis in order to again verify the assumed stability of the instrument response. This modification allowed the TAGA analysts to more efficiently utilize the available instrument time.

3) Criteria Applied in Deciding To Restart TAGA Sampling After Corrective Actions Had Been Taken As a Result of Either an Excessive Response Factor Decay or an Unacceptably High LCIC Detection Limit

After any corrective actions had been taken as a result of either of the above two problems, a new calibration was performed to determine whether the instrument now had the required sensitivity. If it did not, then further corrective actions was warranted. However, if the instrument sensitivity was within specifications, then the response factors from this calibration were entered into the Daily Summary of Response Factors (Figure 4.3.7 of the TAGA SORP) but no % RF decay was computed. A second calibration was then performed in order to ensure that the instrument sensitivity was no longer significantly decaying and that there was no danger of the instrument sensitivity decaying to the point that the resulting detection limits would again be unacceptable. The response factors from the second calibration were also entered in the daily summary (% RF decay computed) and were used as the calibration for the next house or QA/QC analysis provided that the starting of that analysis was pending the completion of the corrective action.

This procedure was further modified, but not documented, by the TAGA group during Phase 2. The second, post-corrective-action calibration was dropped from the procedure provided a) that the decay either had been reversed or had decreased to less than 15% and b) that the new detection limits computed from the first post-corrective-action calibration were less than 2 ppb. In other words, once the appropriate corrective action was taken, only one set of calibration data, not two sets, was used to determine whether the TAGA should continue sampling.

Although this field modification was made without the proper documentation, it did not affect the overall data quality. In all but two cases when this further modification was used the first post-corrective-action calibration indicated an increase in the instrument's sensitivity (i.e., the response factor decay was reversed). In the other two cases, the decay reversed itself by the next house and the instrument detection limits were less than 50% of their maximum allowable values.

4) Use of a Gas Standard Cylinder in Place of Unique 6 Liter Summa Canisters as Performance Evaluation Samples

This replacement was required during Phases 1 and 2 of sampling due to uncertainties encountered with the known concentrations of the initial two batches of Summa canisters from Northrop services. It was not until Phase 3 that the team leader from Northrop Services had sufficient confidence in the "known" concentrations for these canisters to be used as performance evaluation samples. Because this was the first time that RTP had prepared performance evaluation samples for these compounds, these initial problems were not unreasonable and are the price of using non-field-proven "state of the art" methodologies in such an intensive program.

Standard gas cylinders, which were analyzed by the TAGA using the procedures developed for the 6 Liter Summa canister, became the daily QC sample used to certify the daily accuracy of the TAGA. In all performance evaluation analyses different gas standard cylinders were used for the calibration and the actual performance evaluation analysis. These standard gas analyses could not be considered to be an absolute check of the TAGA's accuracy; a bias in the standard gas cylinder certifications could not have been detected since the calibrations and cylinder analyses would have had the same bias. Therefore, Northrop Services challenged the TAGA group with a 16 Liter Summa canister audit sample during each phase. Extra precautions were taken by Northrop Services to ascertain the LCIC concentrations. During all four phases the TAGA's results were within the accuracy criteria. Thus, the data quality was not adversely affected during Phases 1 and 2 by the necessary shift to the Scott standard gas cylinders as the accuracy check samples.

5) Change in the Identification Criteria to Be Applied Whenever an LCIC Concentration Was Greater Than the Quantitation Limit

Whenever an LCIC was detected above its quantitation limit, the original QA/QC plan in the SORP specified that the ratios of the various ion pair signals would be computed and that these ratios would then be compared against the appropriate ion ratio ranges calculated during the previous calibration. This criteria was designed to test for the presence of potential interferences to a given ion pair. This was the first time that ion ratios had been applied to TAGA air monitoring data. Unfortunately, during the quantitation limit verification, the performance evaluation, and the precision canister analyses in Phase 1, this criteria repeatedly failed to correctly identify the presence of pure compounds. Therefore, the use of ion ratios was discarded as a means of testing for interferences. A new and better set of identification criteria was developed from the quantitation limit verification data from the first eight days of Phase 1. This new criteria never failed to correctly identify the pure, spiked LCIC during all subsequent quantitation limit verifications. The new criteria was as follows:

> For any LCIC present above its quantitation limit, concentration values were first computed from the signal for each ion pair and then an average concentration was computed. Next, the software computed the percent deviations of each individual ion concentration from the overall average. The compound was considered to be not interfered with if all of the above percent deviations were less than or equal to 20%. If any individual percent deviation exceeded 20% then the compound was considered to be interfered with and the reported average concentration would have been flagged accordingly. No such interferences were detected during this study.

The ID criteria was initially specified at 15% in the original memo dated August 17. This criteria was widened to 20% in the September 14 summary memo. The 20% criteria was used throughout the sampling program.

Implicit in this modification of the ID criteria were changes in the criteria to be applied during the data review and data validation and changes in several of the predefined data reporting spreadsheets. The data review / validation criteria 11b of Table 7.1 of the SORP was changed to "for each quantitation limit verification analysis check to insure that the reported data met the new ID criteria". The following forms were modified as a result of this ID criteria change:

Figure 1 - The LOTUS Summary of Calibration and Detection Limit Data (Figure 4.3.6 of the SORP).
Figure 2 - LCIC Summary Data for Stationary Monitoring (Figure 4.6.5 of the SORP).
Figure 3 - LCIC Summary Data for Cylinder/Canister Analyses (Figure 4.7.2 of the SORP).
Figure 4 & 5 - Verification of Detection & Quantitation Limits By Serial Dilution (Figure 4.8.1 of the SORP). This form was, in essence, three separate forms designed to report data from three interrelated experiments: a) spikes below the reported detection limits, b) spikes between the detection and quantitation limits, and c) spikes above the detection limits. When this form was modified between Phases 1 and 2, it was broken into three separate but similar spreadsheets. However, because of a change in air sampling pumps between the two phases, the detection limits for the last three phases were always too low for the TAGA group to be able to reliably spike below the reported detection limits. Therefore only the forms for parts b and c of the verification

were generated during the last three phases of the study. The new versions for parts b and c are found in figures 4 and 5, respectively. The two "chlorotoluene concentrations" found in the bottom half of the form should read "chlorobenzene concentrations". The error was seen but never corrected in the LOTUS macro program since it did not affect any of the computed values.

A new version of the "Calculation of Intermediate RFs, DLs, and Resulting % Error Bars" (Figure 4.3.8 of the SORP) was also prepared but has not been included since it was not included in any of the final data packages. (Although the three calibrations were performed during the initial survey and investigative survey of the one house with a detectable level of an LCIC, the response factors were so similar that no intermediate response factors were used in reporting the data. The difference in the reported concentrations were less than the least significant digit of the reported value.)

6) Other Data Forms Which Were Modified During the Study

Two other forms were improved during the study. Figure 6 contains the new version of the Data Flag Versus Sequence Number Table (Figure 4.6.4 of the SORP) which is illustrated in figure 6. This offset allowed the operator to convert the sequence number at which the air was sampled at the head of the hose to the sequence number corresponding to the signal generated when that sampled air actually reached the TAGA. In most cases, these offset sequence numbers were used to reduce the stored data. One of the only exceptions, during which an offset sequence was not used in reducing the data, was the start sequence for the first location sampled during a file when the hose had been stationary for several minutes (e.g., the initial ambient air analysis for a given house). This improved form was first used during Phase 1 of the study.

The Summary of Results From Precision Analyses (Figure 4.7.3 of the SORP) was also modified. The new form, which is contained in Figure 7, summarizes the results from both LCICs in one table rather than two and includes the results from all cylinder and canister analyses from that phase which could be used to evaluate the precision. It also calculates the %error of the average concentration versus the "known" concentration. The new form does not include the dilution data since that data is contained in the LCIC Summary Data for Cylinder/Canister Analyses (Figure 3) which are included in the daily data packages.

7) Modification to the Procedures Used in Analyzing the Precision and Performance Evaluation Samples

The procedure for analyzing this samples given in section 4.7 of the SORP stated that "Immediately after initiating the data acquisition, the operator will open the cylinder/canister and will start feeding the gas through the dilution system." This procedure was changed to allow the operator to start feeding the sample gas to the dilution system prior to starting the data acquisition. This change did not affect the data quality but did allow the TAGA crew to save valuable time in performing the analyses. The justification for this change is discussed in detail in the above-mentioned September 14 memo.

8) Use of an Unheated Teflon Line in Sampling a Given House

Method development performed between the first and second phases determined that no loss of either LCIC occurred when an unheated Teflon line was used at ambient air temperatures as low as $0^{o}C$. Therefore, due to the various handling problems associated with the heated transfer lines, unheated Teflon lines were used. The use of an unheated transfer line greatly decreased the time spent at each sampled residence. Additionally, because an unheated lines was used during the % Transport Efficiency Analyses, the outside ambient temperature was recorded on the TAGA Operator's Logsheet for each test performed. The outside ambient temperature was also recorded at each house and these temperatures were checked against the lowest temperature for which a set of % Transport Efficiencies had been obtained.

9) Spike Concentration Used When the Detection Limits of the Two LCICs Differed by More Than 1ppb

Whenever the detection limits of the two LCICs differed by more than 1ppb, then the detection limit and quantitation limit determinations were performed at the lowest possible dilution which was within 1 and 2 ppb of the higher of the two detection and quantitation limits, respectively. The original set of operating procedures had not considered the possibility that either the detection limits or the quantitation limits for the two LCICs would differ by more than 1 ppb. This modification addressed that situation.

10) Maximum Acceptable TAGA Starting Vacuum Pressure

The original SORP specified that the TAGA must have pumped down to at least 2 X 10^-7 torr before the TAGA crew could start preparing the instrument for that day's analyses. This criteria was based upon the manufacturer's recommendations and upon a two hour shift in startup times for each day. According to the manufacturer starting analyses before this pressure was reached could both shorten the usable life of the instrument for that day and could result in a severe decay in the instrument sensitivity towards the end of the day. Starting in Phase 2, it was not always possible to obtain this manufacturer's maximum recommended starting pressure with the shift to fixed start times for three continuous days at a time. On several days during the last three phases the start time of the analyses would have had to be delayed in order to meet this criteria. However, the existing QA/QC plan was designed to quickly detect the very problems the maximum acceptable starting pressure was designed to help prevent (changes in instrument response). Therefore, the maximum acceptable TAGA starting vacuum criteria was replaced by the judgment of the TAGA Senior Scientist. At no time during the study was an analytical problem ever traced back to the TAGA group starting up the instrument before the maximum acceptable pressure was obtained.

11) Alternate Method for Computing Detection Limits When Ambient Air Was Potentially Contaminated by LCIC

During the last two phases of the program, the background ambient air occasionally gave rise to elevated signals for a given LCIC. Once during the last phase the ambient signal was even greater than the detection limit. In several occasions, an LCIC signal actually dropped when the TAGA sampling line was moved into the houses. The detection limit computations developed for this QAPP were based upon the assumption that the LCICs were unique to Love Canal and were not normally present in the ambient air in the EDA. Elevated signals during the calibration zero point determinations would bias the computed detection limits high and could have potentially resulted in false negatives. A total of fifteen calibrations were affected - 5 during Phase 3 and 10 during Phase 4. Therefore, an alternate procedure was developed for dealing with these infrequent elevated signals.

The alternate procedure was as follows:

> First, a clean calibration was selected for the effected LCIC from the calibration data for that day. The "clean" calibration was defined as the closest calibration in which the average zero concentration signal for the affected LCIC was within one standard deviation of the average signal for the unaffected LCIC. The alternate detection limit was then computed by dividing the original detection limit by a correction factor. This correction factor was computed by averaging individual ion pair ratios which were calculated by taking ion pair response factors from the "clean" calibration and dividing them by the response factors from the affected calibration. Thus, if the instrument sensitivity had doubled from the "clean" calibration to the affected calibration (i.e., the response factors had increased by a factor of two), the alternate, corrected detection limit would be half of the detection limit computed from the "clean" calibration.

Because this was not the approved detection limit calculation, the values reported in the final report were those computed using the original calculations. However, these values are flagged and the appropriate tables, which can be found in the report Reference section, are designated. In all cases the appropriate house data were compared against both sets of detection limits. There were no LCIC levels which would have changed to a "detect" using the alternate detection limits from a "non-detect" using the original limits. Therefore, this potential bias was considered but no false positives were found among the fifteen houses with the affected detection limits.

12) Data Review Activity Logsheet

The SORP stated that this logsheet would be formalized. However, it was found that the each data review crew worked better using their own informal checklists. These checklists were too cryptic for interpretation by non-TAGA users but were more than adequate to insure that the data review was completed in a thorough manner. This effectiveness was evidenced by the lack of significant errors and omissions having to be caught by the data validation step. Therefore, no formal data review activity logsheet was ever developed.

13) Data Validation Activity Logsheet

This logsheet was again specified as "Yet to be Completed" in the SORP. This logsheet was formalized into a two part form (Figures 8 & 9). The logsheet served two purposes. The first part (Figure 8) summarized the QA/QC results for that day's analyses and compared the reported QC results against the appropriate Data Quality Objectives. The second part (Figure 9) listed any data discrepancies which had the potential of affecting the data quality. Each item listed was then specifically reviewed by the ERT QA/QC Coordinator in order to determine the necessary corrective action. The actions included A) no action needed - data quality not affected, B) Data Review action required in order to resolve and document the noted discrepancy, C) explanatory memo required from the ERT QA/QC coordinator documenting his professional judgment on the degree, if any, to which the data quality was affected, and D) withdraw the affected data package from the overall package; no corrective action possible except for resampling.

14) No End-of-Phase SAF & MFC Calibration Checks for Phases 1 & 3

Table 6.3.1 of the SORP states that the SAF and MFC calibrations were to be rechecked prior to the TAGA demobilizing from each phase. It did not define the time period which corresponded to "before demobilizing". Consequently, in Phases 1 & 3 the last set of MFC and SAF calibration checks were not performed on the last day of the phase. In Phase 1, the last calibrations checks were performed on the twelfth day of a fourteen day sampling effort and in Phase 3 they were performed between the sixth and seventh days of a nine day effort. In both cases, the measured calibration errors never exceeded 7% (Phase 3) and 8.6% (Phase 1) for the SAF and MFC calibration checks. Also, when these calibrations were first checked in the subsequent mobilization the maximum errors were 8.22% (Phase 2) and 3.61% (Phase 4) for the MFC and SAF calibration checks. Although the measured errors from these calibration checks did vary throughout the program, they never exceeded the 10% criteria. Therefore, it would have been extremely unlikely that either calibration had drifted outside of the 10% criteria during those last two days of each phase, especially when they were inside the criteria during the first check of the subsequent phases. Consequently, it is highly unlikely that these two deviations from the calibration check schedule adversely affected the data quality.

CHANGES IN THE PHASE-SPECIFIC DOCUMENTATION

Section A of Table 9-1 of the SORP describes the required, additional documentation for each two week sampling effort. These documents were beyond those which would be included in the house and daily data packages. All of these documents have been moved to other locations within the total data package as described below.

The documentation for the following items have all been placed in the data package immediately prior to the data from the first day of the first mobilization: the initial certification and the recertifications of the standard cylinder concentrations by Scott Specialty Gasses (Figure 3.4.1 of the SORP) and by Northrop Services, the certification of the rotameter calibration (NBS-traceable), and the certification of the Gilian PFS 500 Microprocessor Flow Calibrator. The latter two certifications, which were only documented once, were applicable to the complete sampling effort. However, the certifications were indirectly reconfirmed for each phase by the independent MFC and SAF flow audits which were performed by Northrop Services. These audits were always performed on the same days that the SAF and MFC calibrations were checked by the rotameter and MFC, respectively.

The standard cylinder recertifications performed by Northrop Services were only officially documented once during the program. All other communications of the recertification results were through verbal communications and informal memos. Because of the time required for each analysis the actual recertifications of each of the standard cylinders by Scott Specialty Gasses were interspersed throughout the total program. In other words, only selected cylinders were recertified by Scott prior to each phase. All of these recertification results are summarized in Tables 37 & 38 of Volume 1 of the TAGA group's final report. This summary also indicates when each recertification analysis was performed. Consequently, the documentation for all of the individual Scott recertification analyses are presented together with the documentation of the Northrop recertifications. These documents are in Appendix 1.

The documentation of the initial SAF and MFC calibration checks were moved into the data package for the first day of that particular phase while the summary of the results from the precision analyses were included as the last item for that particular phase. This form (Figure 4.7.3 of the SORP) was modified and these modifications are discussed above in section 6. An example of the new form for reporting this data is contained in Figure 7 of this report.

Two sets of documents were dropped from the packages: the summary TAGA Operating Logsheets (Figure 4.1.1 of the SORP) and the Cylinder/Canister Chains of Custody (Figure 3.4.2 of the SORP).

The summary logsheets were dropped since new, individual logsheets were filled out each day. These individual logsheets were included in each daily data package. The chains of custody were dropped because their use became sporadic after Phase 1. The identity of each canister was clearly labeled and there never arose an occasion in which a chain of custody was needed to resolve which canister was being analyzed. Additionally, because of the uniqueness of these canister samples, it would not have been possible for any company or any other government agency to have supplied us with Summa canisters containing the LCICs at the 10 - 25 ppm spiked concentrations during this study. Therefore, the lack of proper chains of custody for all of these canisters does not affect the data quality.

CLARIFICATION OF THE AMBIGUITIES AND CORRECTION OF ERRORS IN THE ORIGINAL CRITERIA SPECIFIED IN THE SORP

There were several ambiguities and errors in the SORP procedures and criteria which became apparent during the sampling. These were caused by the fact that the QAPP was finalized before many of the procedures described in the SORP were fully field tested. These errors and their corrections are summarized below:

1) The maximum allowable percent decay in the response factors is reported as 15% in Table 4-1 of the main body of the QAPP but as 30% in Table 6.3.1 and the text of Appendix A of the QAPP. This discrepancy resulted from a change in the QAPP not being incorporated into the SORP. The correct value was 15%.

2) The SORP did not specify whether the decay criteria was to be applied to the average decay or each individual ion pair response factor. The criteria was applied to the average decay.

3) The 10% criteria listed for "Perform Periodic Calibrations" in Table 6.3.1 of the SORP can not be applied to the actual calibrations. This accuracy criteria was actually the criteria of the SAF and mass flow controller calibrations. It was the accuracy of those two sensor calibrations that, along with the accuracy at which the standard gas concentrations were known, determined the overall accuracy of the TAGA calibrations.

4) In the verification/criteria listed in Table 7.1 of the SORP criteria 12 and 13 have figures misidentified. Specifically, in criteria 12 Figure 4.7.2 should be Figure 4.8.1 and in criteria 13 Figure 4.8.1 should be Figure 4.9.2.

5) In Figure 4.1.4, the instrument startup checklist, the required temperatures for items four and five were reversed. Specifically, the required temperature for Cryoshell Temperature #2 should have been $\leq 75^{o}$K and the required temperature for Cryoshell Temperature #3 should been $\leq 18.5^{o}$K.

6) Throughout the SORP two different source pressure ranges were used (0.9-1.1 torr versus .950-1.050 torr). The 0.9-1.1 torr range was considered the proper criteria range.

7) The SORP did not specify which of the two concentration values (Average versus Actual) reported in the results of the Verification of Detection & Quantitation Limits analysis (Figure 4.8.1) should have been within 1 ppb and 2 ppb of the detection limits and quantitation limits respectively. Since the "Actual Concentration" was the actual diluted spiked concentration, it was always the concentration compared against the quoted detection and quantitation limits.

8) The SORP failed to specify that the accuracy of the TAGA was also to be evaluated during the quantitation limit verification. This was an error of accidental omission which was caught by the data validation crew during the first phase of sampling. The percent error in the calculated "Average Concentration" was computed for each quantitation limit verification to ensure that the accuracy of the TAGA at its quantitation limit was within the specified 25%. The percent error was calculated as follows:

$$\%error = |average - actual|/actual \quad X\ 100.$$

9) While the SORP used integer values throughout all of its criteria, the actual computed values for the various criteria were computed as real numbers with fractional components. Therefore, prior to a computed criteria being compared to the SORP specified value, the computed criteria was always rounded to the closest whole number using the standard rules for rounding.

10) Criteria 6 in Table 7.2 of the SORP specified that the entries in the TAGA chronological logsheet should have been consistent with the appropriate entries in the TAGA logsheet. One of these entries was the source pressure reading. The gauge which measured this reading was only precise to an hundredth of a torr and had a typical measurement noise of 0.002 torr. The SORP never specifically addressed this issue and the matter was raised during the data validation. The criteria was further defined such that the two readings were considered equal if they were within 0.004 torr from each other.

11) The quadrupole warmup time criteria listed in the Instrument Startup Checklist accidentally was given as ≤ 30 minutes both on the sheets and in the SORP. The correct value was ≥ 30 minutes.

12) Data Quality Objective #2 in Table 6.1.1 of the SORP defined the maximum allowable precision of the TAGA analyses to be 25% as measured by "(% error in the reported concentration)". In addition, criteria 10 of Table 7.1, which outlines the data review checks, also includes a check on the accuracy of the analysis. Since this is the same wording as was used in defining the accuracy criteria in Data Quality Objective #1 of the same table, the wording implies that for each precision analysis the percent error of the reported concentration from the known value was to

be compared against this precision criteria and that this comparison would determine the overall precision of the TAGA. However, Figure 4.7.3 in the SORP, which shows the format that was to be used in reporting the precision results, indicate that a percent relative standard deviation (RSD) was to be computed. This ambiguity arose from the fact that the data was being used for two related but different purposes: 1) an internal check or control analysis (accuracy evaluation) and 2) a repetitive sample of constant concentration (precision evaluation). In the data packages, the percent errors were calculated in the data summary reports (Figure 3 of this report) for each analysis and a RSD was computed for each set of precision analyses (Figure 7 of this report).

The RSDs were used in both the TAGA group's final report and my summary of the TAGA's performance to evaluate the TAGA's precision against this criteria. Each precision analysis was also treated as an internal control sample and a percent error was computed. However, the comparisons of these percent error results were included in the discussions of the TAGA's accuracy versus the accuracy criteria of "less than a 25% error".

Because of the affect this ambiguity had on the review of the TAGA's performance against the data quality objectives, I discussed it with Bill Coakley, the ERT's Quality Assurance Officer. He concurred that only a standard deviation or a relative standard deviation were appropriate measures of precision. He also concurred with the use of the percent error of these analyses as another measure of the overall accuracy of the TAGA (Data Quality Objective #1).

ADDITIONAL PROCEDURES ADDED

Several additional QC procedures and data validation steps were added to the field analyses. These procedures were designed to further improve the overall data quality even beyond what was originally specified in the QAPP. These additional procedures are as follow:

1) Check of Accuracy at the Quantitation Limit

Although never specified in the QAPP or the Data Quality Objectives, it was implicit in the design of the quantitation verification that the quantitative accuracy of the TAGA should be checked whenever a quantitation limit verification occurred. Therefore, starting in Phase 2, the Verification of Quantitation Limits spreadsheet (Figure 5) was modified to calculate the error in each quantitation limit verification spike analysis. Both the data review and data validation groups were then tasked to check the reported error against the 25% accuracy criteria. In all cases the reported values met this accuracy criteria.

2) Additional Documentation of the Correct Sampling Air Flow and Collision Gas Thickness Values

In Phase 2, the TAGA senior scientist noticed that the Sampling Air Flow (SAF) and Collision Gas Thickness (CGT) readings occasionally were affected when the TAGA initiated a data-stored-to-file acquisition but not during the normal no-storage acquisitions. He further determined that the settings themselves had not changed but that the problem was apparently just a computer gliche. Therefore, he initiated the inclusion of real-time, no-storage, ion signal versus time trace (Figure 10) to each data package. From then on, this sheet was used to get the correct SAF, CGT, and discharge current (DI) readings.

FIGURE 1

```
                CALIBRATION AND DETECTION LIMIT DATA

                     Date:  1-DEC-87
                     Time: 08:10:39
                 Filename: MLC4003

==============================================================================
                                 Chlorotoluene
    Conc.  126.0/  91.0       sd1 126.0/  65.0       sd2 128.0/  91.0       sd3
    ppb v          icps      icps         icps      icps         icps      icps
------------------------------------------------------------------------------
      0.0            11         7           11         6            7         3
      2.0           206        15           57        15           78        13
      4.1           409        45           89        12          134        20
      8.1           845        39          183        19          289        22
     16.3          1600        43          359        28          545        34
     26.1          2692       103          569        39          877        37
------------------------------------------------------------------------------
       RF      101.9083               21.41719                33.2422
 y-intcpt     -1.317665               9.196483               7.924579
       R2        0.9996                 0.9998                 0.9998
------------------------------------------------------------------------------
                               Detection Limits
intensity            25                     23                     13
   ppb              0.2                    1.1                    0.4

  Intensity of the most sensitive ion pair at compound DL        109.4

 Chlorotoluene quantitation limit (ppb)=             3.2
==============================================================================

                                          Chlorobenzene
     Conc. 112.0/  77.0       sd1 112.0/  51.0       sd2 114.0/  77.0       sd3
     ppb v         icps      icps         icps      icps         icps      icps
------------------------------------------------------------------------------
       0.0           14         6           12         5           13         6
       2.0          182        19          143        22           62         8
       4.1          345        37          270        36          126        13
       8.1          715        39          559        33          239        16
      16.3         1374        61         1051        46          437        30
      26.1         2248        94         1736        48          738        46
------------------------------------------------------------------------------
        RF     85.30179                65.6271               27.46773
  y-intcpt     7.882652               9.107127               9.757792
        R2       0.9999                 0.9998                 0.9993
------------------------------------------------------------------------------
                               Detection Limits
intensity            26                     22                     25
   ppb              0.3                    0.3                    0.9

  Intensity of the most sensitive ion pair at compound DL         77.6

 Chlorobenzene quantitation limit (ppb)=             2.7
------------------------------------------------------------------------------
```

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FIGURE 2

```
               LCIC SUMMARY DATA FOR STATIONARY MONITORING

FILE: LC4004
[redacted]
START SEQUENCE:    1
END SEQUENCE  :  604
LOCATION:
=======================================================================
                                        INTENSITY             PPB  %DEV FR
ID          PM/DM       RF       DL        AVG        SD      AVG AVG CONC
CTOL     126.0/  91.  101.91   0.25         15        13     0.15   62.95%
CTOL     126.0/  65.   21.42   1.07         14        12     0.65   64.53%
CTOL     128.0/  91.   33.24   0.39         13        12     0.39    1.57%

         AVERAGE CHLOROTOLUENE CONCENTRATION                 0.4
-----------------------------------------------------------------------

    AVERAGE % DEVIATION FROM CONCENTRATION AVG   43.02%        ________

                             DETERMINATION                     BDL

=======================================================================
                                        INTENSITY             PPB  %DEV FR
ID          PM/DM       RF       DL        AVG        SD      AVG AVG CONC
CBEN     112.0/  77.   85.30   0.30         16        27     0.19   32.83%
CBEN     112.0/  51.   65.63   0.34         14        12     0.21   23.61%
CBEN     114.0/  77.   27.47   0.91         12        12     0.44   56.44%

         AVERAGE CHLOROBENZENE CONCENTRATION                 0.3
-----------------------------------------------------------------------

    AVERAGE % DEVIATION FROM CONCENTRATION AVG   37.6%         ________

                             DETERMINATION                     BDL

=======================================================================
```

FIGURE 3

```
          LCIC SUMMARY DATA FOR CYLINDER\CANISTER ANALYSES

FILE: LC4001
PRECISION CYLINDER AAL16555
START SEQUENCE:            220
END SEQUENCE:              332            SAF RDG:      1503 ml/sec
CYLINDER ID:         AAL16555            MFC RDG:        35 ml/min
=====================================================================
                                 INTENSITY                PPB   %DEV FR
ID         PM/DM          RF        AVG        SD        AVG  AVG CONC
CTOL      126/ 91      97.54       1234       113       12.7      4.8%
CTOL      126/ 65      19.82        275        52       13.9      4.5%
CTOL      128/ 91      30.46        406        69       13.3      0.3%

  AVERAGE CHLOROTOLUENE DILUTED CONCENTRATION          13.3 ppb
ORIG. CHLOROTOLUENE CONCENTRATION IN CYLINDER          34.2 ppm
---------------------------------------------------------------------

        AVG % DEVIATION FROM DILUTED CONC                3.2%

                 %ERROR IN FINAL CONC              ___14.3%___

=====================================================================
                                 INTENSITY                PPB   %DEV FR
ID         PM/DM          RF        AVG        SD        AVG  AVG CONC
CBEN      112/ 77      80.60       1004       106       12.5      2.7%
CBEN      112/ 51      62.05        787        88       12.7      1.0%
CBEN      114/ 77      25.45        338        60       13.3      3.7%

  AVERAGE CHLOROBENZENE DILUTED CONCENTRATION          12.8 ppb
ORIG. CHLOROBENZENE CONCENTRATION IN CYLINDER          33.0 ppm
---------------------------------------------------------------------

        AVG % DEVIATION FROM    UPPER     LOWER          2.5%

                 % ERROR IN FINAL CONC              ___20.7%___

=====================================================================
```

FIGURE 4

```
     VERIFICATION OF DETECTION & QUANTITATION
       LIMITS BY SERIAL DILUTIONS (cont)

FILE: LC4020
DETECTION AND QUANTITATION LIMIT VERIFICATION
   ORIGINAL CYLINDER CHLOROTOLUENE CONCENTRATION (ppm)   26.33
   ORIGINAL CYLINDER CHLOROBENZENE CONCENTRATION (ppm)   25.54

START SEQUENCE:         115          SAF RDG:     1547 ml/sec
END SEQUENCE:           223          MFC RDG:        5 ml/min
=================================================================
                            INTENSITY      PPB     INTNS      PPB
ID       PM/DM          RF        AVG      AVG        DL       DL
CTOL  126.0/  91.0  170.33        233      1.4        24     0.14
CTOL  126.0/  65.0   37.29         61      1.6        21     0.56
CTOL  128.0/  91.0   50.24         77      1.5        28     0.56

    AVERAGE CHLOROTOLUENE CONCENTRATION (ppb)     1.5
     ACTUAL CHLOROTOLUENE CONCENTRATION (ppb)     1.4
-----------------------------------------------------------------

              DETECTED?     Yes



=================================================================
                            INTENSITY      PPB     INTNS      PPB
ID       PM/DM          RF        AVG      AVG        DL       DL
CBEN  112.0/  77.0  154.64        209      1.4        27     0.17
CBEN  112.0/  51.0  113.36        155      1.4        29     0.26
CBEN  114.0/  77.0   47.25         76      1.6        24     0.51

    AVERAGE CHLOROBENZENE CONCENTRATION (ppb)     1.4
     ACTUAL CHLOROBENZENE CONCENTRATION (ppb)     1.4
-----------------------------------------------------------------

              DETECTED?     Yes



=================================================================
```

FIGURE 5

```
     VERIFICATION OF DETECTION & QUANTITATION
       LIMITS BY SERIAL DILUTIONS, PART 3
       VERFICATION OF QUANTITATION LIMITS
FILE: LC4020
DETECTION AND QUANTITATION LIMIT VERIFICATION
   ORIGINAL CYLINDER CHLOROTOLUENE CONCENTRATION (ppm)    26.33
   ORIGINAL CYLINDER CHLOROBENZENE CONCENTRATION (ppm)    25.54

START SEQUENCE:        437          SAF RDG:    1547 ml/sec
END SEQUENCE:          546          MFC RDG:      11 ml/min
=================================================================
                            INTENSITY      PPB   DEV FR    % DEV
ID       PM/DM          RF        AVG      AVG      AVG   FR AVG
CTOL  126.0/  91.0  170.33        523      3.1      0.1     4.3%
CTOL  126.0/  65.0   37.29        125      3.4      0.1     4.5%
CTOL  128.0/  91.0   50.24        161      3.2      0.0     0.1%

AVG CHLOROTOLUENE CONCENTRATION (ppb)      3.2      AVG     3.0%
ACT CHLOROTOLUENE CONCENTRATION (ppb)      3.1
-----------------------------------------------------------------
                                                         ACCEPT
AVG % DEVIATION FROM COMPUTED AVG          3.0%         ______

%ERROR FROM ACT SPIKED CONCENTRATION       2.8%         __yes__

=================================================================
                            INTENSITY      PPB   DEV FR    % DEV
ID       PM/DM          RF        AVG      AVG      AVG   FR AVG
CBEN  112.0/  77.0  154.64        457      3.0      0.2     6.3%
CBEN  112.0/  51.0  113.36        356      3.1      0.0     0.4%
CBEN  114.0/  77.0   47.25        159      3.4      0.2     6.7%

AVG CHLOROTOLUENE CONCENTRATION (ppb)      3.2      AVG     4.5%
ACT CHLOROTOLUENE CONCENTRATION (ppb)      3.0
-----------------------------------------------------------------
                                                         ACCEPT
AVG % DEVIATION FROM COMPUTED AVG          4.5%         ______

%ERROR FROM ACT SPIKED CONCENTRATION       4.2%         __yes__

=================================================================
```

FIGURE 6

Parameters Multiple Ion
File: LC4004 Acquired on: 1-DEC-87 At: 08:18:42
Title: [redacted]

RESIDENCE TIME: 57
MINUTES/SEQUENCE: 0.01854
OFFSET SEQUENCE #: 51

Sequence	Offset Sequence		Time	Flag
5	56	Amb.	0.07	A
59	110		1.05	B
78	129	Living	1.39	C
133	184		2.39	D
141	192	Dining	2.54	E
196	247		3.54	F
203	254	Bed#1	3.67	G
259	310		4.69	H
266	317	Bath	4.82	I
322	373		5.84	J
331	382	Kitchen	6.00	K
386	437		7.00	L
394	445	Bed#2	7.15	M
449	500		8.15	N
458	509	Amb	8.31	O
597	648		10.85	P
600	651		10.90	Q

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SUMMARY OF THE PHASE 2 PRECISION RESULTS

RESULTS FROM THE SCOTT CYLINDER PRECISION ANALYSES

		CERTIFIED CONC.		TAGA ANALYSES RESULTS		% DEV. FROM MEAN	
CYL. ID.	DATE	PPM-CTOL	PPM-CBEN	PPM-CTOL	PPM-CBEN	CTOL	CBEN
AAL15177	9/15/87	25.99	25.53	23.0	23.6	-11.8%	-10.1%
AAL15177	9/16/87	25.99	25.53	23.3	24.0	-10.6%	-8.6%
AAL15177	9/17/87	25.99	25.53	26.9	27.8	3.2%	5.8%
AAL15177	9/18/87	25.99	25.53	25.1	25.6	-3.7%	-2.5%
AAL15177	9/19/87	25.99	25.53	27.3	26.8	4.7%	2.0%
AAL15177	9/21/87	25.99	25.53	27.7	28.0	6.2%	6.6%
AAL15177	9/22/87	25.99	25.53	27.2	27.8	4.3%	5.8%
AAL15177	9/23/87	25.99	25.53	26.4	26.7	1.3%	1.7%
AAL15177	9/24/87	25.99	25.53	25.3	26.4	-3.0%	0.5%
AAL15177	9/25/87	25.99	25.53	28.0	25.9	7.4%	-1.4%
AAL15177	9/26/87	25.99	25.53	26.6	26.3	2.0%	0.1%
AVERAGE ANALYZED CONCENTRATION - PPM				26.1	26.3		
%ERROR OF AVG. CONC. FROM THEO CONC.				0.3%	2.9%		
STD DEV. OF ANALYZED CONC.-PPM				1.7	1.5		
% RELATIVE STD DEV. OF ANALYZED CONC.				6.5%	5.5%		

RESULTS FROM PRECISION 16-L SUMMA CANISTERS

		RTP THEORETICAL CONC		TAGA ANALYSES RESULTS		% DEV. FROM MEAN	
CANISTER ID.	DATE ANALYZED	PPM-CTOL	PPM-CBEN	PPM-CTOL	PPM-CBEN	CTOL	CBEN
PEB-1A	09/16/87	36.6	31.5	36.5	30.3	-3.7%	-1.8%
PEB-1A	09/18/87	36.6	31.5	36.8	30.2	-2.9%	-2.1%
PEB-1A	09/21/87	36.6	31.5	39.3	30.8	3.7%	-0.1%
PEB-1A	09/23/87	36.6	31.5	38.9	30.4	2.6%	-1.4%
PEB-1A	09/26/87	36.6	31.5	38.0	32.5	0.3%	5.4%
AVERAGE ANALYZED CONCENTRATION - PPM				37.9	30.8		
%ERROR OF AVG. CONC. FROM THEO CONC.				3.6%	-2.1%		
STD DEV. OF ANALYZED CONC.-PPM				1.2	1.0		
% RELATIVE STD DEV. OF ANALYZED CONC.				3.3%	3.1%		

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FIGURE 7

FIGURE 8

DATA VALIDATION COMMENTS LOG

Date of sampling: 9/15/87
Date data package received: 9/17
Date D.V. Logsheet completed: 9/19
Date data package finalized: ________

To minimize errors related to instrument response, check the following:

ACTION	FREQUENCY	CRITERIA	COMMENTS
SAF Calibration	1)upon arrival at LC 2)weekly thereafter 3)before demobilizing	<10% Error	Days since last check 1
MFC Calibration	1)upon arrival at LC 2)weekly thereafter 3)before demobilizing	<10% Error	Days since last check 1
% Transport Efficiency	1)start of day 2)end of day	> or = 85%	OK
Verification of Calculated Quantitation Limits	1)end of day	1)within 1ppb of calculated Quant. Limits 2) <25% Error	OK
Accuracy and Precision using Cylinder/ Canister of known conc.	1)cylinder -- start of day 2)canister -- every other day, at end of day	<25% Error	1) CTOL 11.5% CBEN 7.6%
Accuracy using PE Cylinder/ Canister	1)one PE cylinder/ canister a day, at start of day	<25% Error	CTOL 5.3% CBEN 5.6%
Response Factor Decays	1)every calibration	all average RF Decays < or = 15%	OK

FIGURE 9

KEY:

A = Comment does not affect data quality.
B = Comment requires Data Review action.
C = Comment requires explanatory action by ERT QA/QC Coordinator.
D = Comment requires house data package withdrawal
(house to be scheduled for resampling).

COMMENTS:

1) A______ B THP C______ D______

No data flag vs. sequence tables for files: LC2001, LC2002, LC2003, LC2010, LC2011, LC2012

2) A THP B______ C______ D______

In accordance with QAPP/SDRP revisions (T.P. 9/14), shouldn't cryoshell temps. 2 & 3 on Instr. Startup Checklist be reversed?

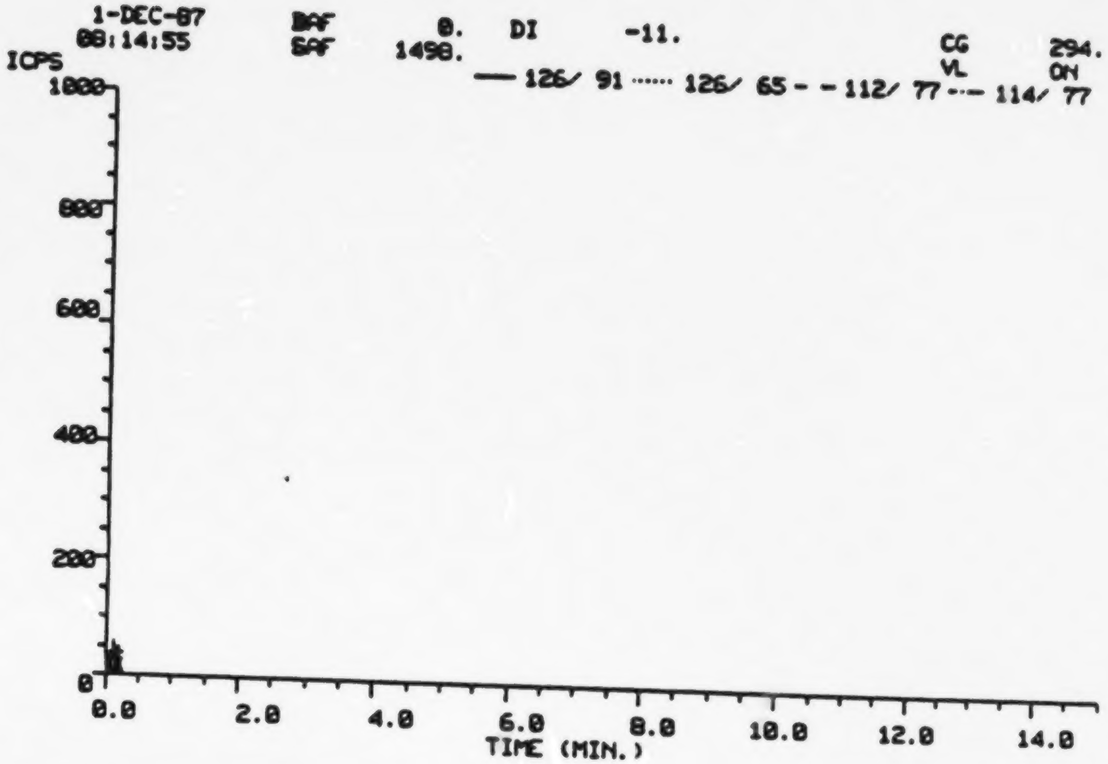
3) A______ B______ C______ D______

4) A______ B______ C______ D______

5) A______ B______ C______ D______

6) A______ B______ C______ D______

FIGURE 10



```
1-DEC-87        BAF      0.   DI     -11.
08:14:55        SAF   1490.                          CG      294.
                                                     VL      ON
```

[redacted]

```
TT      15.0   OR      0.0   IN       0.0   RE3    150.   SY    260.
PE       0.0   CB      0.0   MU   -3400.    RE1    107.   OP    VCK
TH      10.    L3    -30.0   FP      20.0   R1     -6.6   IS    APCI
MTL     0.100  L4    -35.0   DM3     0.210  R2    -50.0   G1    0.000
C        1.    L5      0.0   DM1     0.190  R3     -7.0   G2    0.000
TO    1000.    L6      0.0                                G3    0.000
YS       0.0
```

APPENDIX B
Memorandum:
Further Replies to Peer Review Comments, June 13, 1988 (Revised July 7, 1988)

Air Assessment--Indicator Chemicals

Prepared by

U.S. EPA Environmental Response Branch
Environmental Response Team
Edison, New Jersey

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
EDISON, NEW JERSEY 08837

June 13, 1988
(revised July 7, 1988)

MEMORANDUM

SUBJECT: Further Replies to Peer Review Comments on the Love Canal Emergency Declaration Area Full Air Study

FROM: Thomas H. Pritchett, ERT QA/QC Coordinator (Love Canal)
Environmental Response Branch

Bruce Peterson
CH2M Hill, Inc., Seattle, WA

TO: Doug Garbarini
Love Canal EDA Habitability Study Project Manager
U.S. EPA Region II, ERRD-NYCRA

The peer reviewers raised several other questions concerning the TAGA analyses and QAPP which I did not address in my first reply memorandum (May 19, 1988). I am addressing those now.

Actual versus Nominal Detection Limits, Dr. Schoenfield pgs. 2-5:

Summary of Comment

Dr. Schoenfield addresses the issue of nominal detection limits (those used by the TAGA group) versus actual detection limits (those defined from a strictly statistical basis). He concluded that the nominal detection limits used may have been lower than the actual statistically derived detection limits. Because of the high number of non-detects seen in the study, he wished to see some discussion of the probabilities of false negatives. From these probabilities confidence intervals could then be reported. Unfortunately, it is not a trivial matter to develop a statistical model which accurately predicts the TAGA's response to a compound as will be shown below.

TAGA & Its Signal Processing

In order to properly evaluate the applicability of various statistical models, one must first have a basic understanding of the TAGA and its signal processing. The TAGA is a multi-channel sequential signal counter. Each channel counts the ions which first pass through one mass filter, are then converted to a different mass, and finally pass through a second mass filter. During the EDA habitability study three unique channels (referred to as ion pairs) were used for each LCIC. The channels (or ion pairs) are counted one at a time for brief time interval (usually 0.1 seconds) each and the signals are then converted to a rate (ion counts per second or ICPS). One cycle through the channels is considered one unique measurement and occurs in just over a second. Typically, at least thirty cycles were acquired for every room in the EDA houses. Thus, when the TAGA obtained a reading for a given LCIC in a room, that reading consisted of averages from over thirty measurements on three separate channels. More detailed descriptions of the TAGA and its data acquisitions can be found in Appendix A of the Love Canal Emergency Area Full Air Study Quality Assurance Project Plan, CH2M Hill, 1986.

These signals have several characteristics which must be taken into account when one is developing a statistical model for estimating detection limits. First, the signal response for each channel of the TAGA is directly proportional to the concentration of that compound. The proportionality constant for each ion pair (channel) is called its response factor and is expressed in units of ion-counts-per-second (signal)/part-per-billion (concentration). These constants can be drastically different for each ion pair for that compound. For example, the addition of 5 ppb of chlorotoluene will result in four times the signal increase in the most sensitive ion pair than the signal increase in the least sensitive ion pair. Second, the overall instrument sensitivity, as measured by the ICPS/ppb(v) response factors, changes throughout the day by as much as a factor of 2 and from day to day by an half an order of magnitude. The relative sensitivity of each ion pair to the other ion pairs for that compound do remain essentially unchanged. Third, unlike a GC/MS the measured response is for a direct sampling, realtime instrument. There are no target compound signal peaks surrounded by baseline signals from the clean carrier gas. Rather, sets of signal intensity averages must be compared against each other to determine if there is a significant difference - similar to the manner that signals from a spectrophotometer are compared. Fourth, the measured signal for each channel is composed of two separate components, a constant background noise signal and the signal due to the compound itself. However, the data reduction software does not zero-correct the signals prior to computing concentrations. Fifth, the standard deviations of the measured signals, converted back to just ions counted, tend to agree with the theoretical values predicted by the Poisson distribution.

Nominal Detection Limits

Because each ion pair channel has a different sensitivity, they would all have different individual detection limits. The signal for the most sensitive ion pair could be well above the background noise while the least sensitive ion pair signal was indistinguishable from the noise. If one requires that all three signals be statistically significant from the background noise, as we did, then the overall compound detection limit will become the detection limit of the least sensitive ion pair. Predicting the probabilities for all three signals becomes complicated by the facts that the different but linked sensitivities of the ion pair signal channels to levels of true compound.

To avoid false positives caused by shifts in the background noise (an intermittent problem in phase 1), an additional detection limit criteria was added. Even if all three signals were above their individual detection limits, the compound was not considered to be detected unless the signal for the most sensitive ion pair gave a concentration reading above the overall compound detection limit. Because of the relative differences in the ion pair sensitivities, the signal for the most sensitive ion pair had to be 2X - 4X greater than its own detection limit in order to generate the signal needed to meet this ID criteria. However, if true compound was responsible for elevated signals, then the elevated signals would have such a relative distribution of intensities on the ion pair channels.

Quality Assurance Plan Coverage of Detection Limit Concerns and Acquired Data

Because of the uncertainties in the true TAGA detection limits (i.e., limit at which the false negative rate is less than 95%) versus the limits used in this study, the quality assurance plan had several features built into the analyses designed to gather data on the validity of the TAGA detection limits. First, at the end of each analysis day (w/ one exception caused by an instrument malfunction) the TAGA group spiked a gas standard into the ambient air at concentrations less than 1 ppb above the nominal detection limit in order to specifically test the TAGA's ability to detect trace levels of LCICs. Forty four detection limit verifications were performed during the study and in all of them the LCICs were successfully detected.

In addition, the TAGA calibrations used concentrations at approximately 2 ppb and 4 ppb. Consequently, many of the calibration curves contained concentration points below, just at, or slightly above the nominal detection limits. Before preceding, it should be noted that, because of the types of errors encountered when using mass flow controllers, the low standard flow rates used to prepare the 2 ppb air concentration were subject to the highest relative errors. Therefore, the relative uncertainty of the true concentration in the air was greatest with the "2 ppb" calibration point.

Forty six (46) chlorotoluene calibrations contained a concentration point less than 0.5 ppb above the nominal detection limit. Of these points 10, or 22%, failed to meet one of the detection limit criteria. The data for these points is summarized in Table 1A. In all ten calibrations the selected concentration point failed to meet the ID criteria of having the signal of the most sensitive ion pair exceed the equivalent signal for the compound detection limit. In only three calibrations the least sensitive ion pair signal failed to exceed its individual detection limit. Eight of these ten false negatives were at concentrations just at or 0.1 ppb above the detection limit. Since all but one of these eight were at the lowest concentration in the curve which had the highest relative error in the true concentration being spiked, many of the observed "false positives" were probably spikes at a true concentration below the nominal detection limits. Thus, a predicted 22% false positive rate would be overly conservative.

Chlorotoluene calibrations from phases one and four were also selected based upon a calibration concentration between 0.5 ppb and less than 1 ppb above the nominal detection limit. One hundred and twelve (112) such calibrations were found. In all cases the data at the target concentrations met all of the detection limit criteria. Thus, we can be certain that the difference between the true detection limits and the used nominal detection limits were less than 1 ppb.

Statistical Models of Detection Limits

Estimators for detection limits for the TAGA are not generally available. However there are estimators of detection limits which have been developed for other instruments which may be applied to the TAGA. Two estimators which have been examined are one based on the instrument response to background (Currie, 1968). A second method is based on the instrument calibration curves (Hubaux and Vos 1967). Each method has its advantages and drawbacks.

a) Minimum Detectable Difference Model

This method is based on the instrument response to the background measurements made during calibrations with ambient air. The basic concept of the method is to estimate the minimum detectable difference between a blank measurement and a detectable concentration. The key parameter required for this estimate is the standard deviation of the instrument response to blanks.

One difficulty with the TAGA data currently available is that its instrumentation produced averages of sets of 5 individual measurements. These averages were themselves averaged to produce estimates of overall standard deviations and means. Therefore the instrument produced standard deviations may not be representative of the individual sample (0.1 sec integration) standard deviation.

The basic procedure for estimating the minimum detectable difference (mdd) (ZAR, 1984) is to calculate

$$\text{mdd} = \text{SQRT}(2\ S_p^2/n') * (t_{alpha,df} + t_{beta,df})$$

where S_p^2 is the estimate of the pooled variance,

$t_{alpha,df}$ is the t statistic critical values for controlling false positives,

$t_{beta,df}$ is the t statistic critical value for controlling false negatives,

and n' is the harmonic mean of the two sample sizes

$$n' = (2*n_1*n_2)/(n_1+n_2)$$

Now for the TAGA the standard deviations provided by the instrument may not represent the individual measurements and the standard deviation of the instrument at the detection limit concentration instrument response are not measured at all. However, since the individual measurements are total counts of ions detected, the distribution of these measurements may be assumed to follow a poisson distribution. This allows the variance of the individual measurements to be estimated by the mean of the individual measurements.

So the mdd can be estimated as follows:

let n be number of measurements of initial ion pair counts, I_0 (50 for Love Canal Air Assessment)
let m be the number of measurements of ion pair counts made at the mdd. (30 for Love Canal Air Assessment)
and let t be the integration time for 1 measurement (0.1 for Love Canal Air Assessment

Then the estimates of the standard deviations (1 is calibration, 2 is measurement at $mdd+I_0$)

$$S_1^2 = I_0/t$$

$$S_2^2 = mdd+I_0/t$$

And the estimate of the pooled standard deviation is

$$S_p^2 = (I_0*(n-1)+(mdd+I_0)*(m-1))/(t*(m+n-2))$$

This can be plugged into the above equation to yield:

$$mdd^2 - ((2*(m-1)*(t_{alpha}+t_{beta})^2)/((m+n-2)*t*n'))*mdd$$
$$-(2*I_0*(t_{alpha}+t_{beta})^2)/(t*n')) = 0$$

Since this is a quadratic equation it can be simplified if

$terma = 1$,

$termb = ((2*(m-1)*(t_{alpha} + t_{beta})^2)/((m+n-2)*t*n'))$,

and $termc = (2*I_0*(t_{alpha} + t_{beta})^2)/(t*n'))$.

Then $mdd = (termb +/- SQRT(termb^2+4*termc))/2$

For 99% confidence and 99% power (1% false positive, 1% false negative rates) $t_{alpha,35} = t_{beta,35} = 2.438$ and for the Air LCIC assessment: n=50, m=30 n'=37.5 df=35 and t=0.1.

So termb= 4.7144 and termc= $12.6802*I_0$.

To then convert the minimal detectable difference (mdd) plus base count back to concentrations, the instrument response factor is divided into the mdd. Again, although each ion pair would have similar values for the mdd as ion counts per second, the conversion of mdd's to concentrations will result in vastly different detection limits for each ion pair (3X -4X difference between least sensitive and most sensitive). Therefore, the overall compound detection limit would be the individual detection limit of the least sensitive ion pair.

b) Calibration Model of Detection Limits

The second method is based on the instrument calibration curve. This method uses the prediction limits of the regression relation to estimate the method detection limit. One disadvantage of this method is that it assumes that the concentrations of analytes used for the are exactly known. In actuality the accuracy of the metering mechanisms is less reliable at low levels. This can increase the apparent non-linearity of the calibration curve. An advantage of the calibration curve method of estimation is that it accounts for not only the uncertainty in measurements at given concentrations but also the uncertainty of the calibration curve.

The calibration curve method uses a regression relation developed from the several levels of calibration concentrations used. This model is:

$$RA_i = a*C_i + b + e_i \quad i=1...n;$$

where n is the number of concentration levels used in the calibration.

Let C' be the mean of the C_i,
a' be the estimate of a,
and b' be the estimate of b.

Then

$$SSC = sum_i(C_i-C')^2,$$

$$MSE = (sum_i(RA_i{}^2) - b'*sum_i(RA_i) - a'*sum_i(C_i RA_i))/(n-2),$$

$$t = t_{alpha,n-2} = t_{beta,n-2} \text{ critical value of t statistic,}$$

and $T = t*SQRT(MSE*((n+1/n)+(C'^2/SSC)))$

Finally,

$$MDL = ((2*a'*T - (2*t^2*C'*MSE/SSC))/(a'^2 -(t^2*MSE/SSC)).$$

The derivation of this equation is shown in the Pilot Study for Love Canal EDA Habitability Study Volume 1 Appendix E (CH2M HILL 1987).

c) Summary of Model Limitations

Both adaptations of standard method for estimating detection limits have difficulties with aspects of the TAGA operation not represented in the statistical model. The blank response method assumes that the variability of the instrument in response to a blank, which is primarily electronic noise, is similar to the variability of the instrument response to a detectable level of an analyte, which is due to a combination of both chemical and electronic noise. The calibration curve method assumes that the instrument variability is constant over the linear calibration range and that the concentrations used during calibration are exact. Both methods therefore give approximations to the detection limit but with unknown biases due to the assumptions that must be used with either method.

In addition, both methods make their predictions based upon only one ion pair signal. In their derivations both models assume that the critical values for false negatives, t_{beta}, and false positives, t_{alpha}, are equal. This assumption is only true when one is dealing with only a single signal. The TAGA was using three interrelated signals for each compound. The true alpha and beta values needed for 99% confidence will be somewhere between the values used by the above methods and the alpha and beta values that would be predicted by the probability of three separate random events occurring simultaneously (false positive) or individually (false negative). Because these signal averages are interrelated but still subject to random errors of different magnitude with different relative effects on the final determination, the true probabilities of type I and type II errors may not agree with the statistically predicted probabilities. For example, a false negative determination could result from slight random ion counting errors in either the 112/51 or 114/77 ion pair signals causing the reported averages to fall below the individual ion detection limits or could result from a similar but different magnitude ion counting error in the 112/77 signals causing the reported average to fail to meet the ID criteria. At a given threshold the probability of such a false negative occurring will be drastically different than the false positive probability of random errors simultaneously causing all three averages to exceed their individual detection limits and the most sensitive ion average to exceed the ID criteria.

Comparison of Model Detection Limits With Love Canal Calibration Data

Table 1B contains a comparison of the predicted and nominal detection limits for ten of the calibrations in which both compounds were present at less than 1 ppb but greater than or equal to 0.5 pbb above the nominal detection limits. Table 1C contains a similar comparison of the various detection limits for chlorotoluene calibrations for which all "detect" criteria were met at a concentration less than 0.5 ppb above the nominal detection limit. Table 1D contains another set of comparisons for the chlorotoluene calibrations for which a false negative occurred at a concentration above the nominal detection limits.

Some trends can be discerned from this data. First, the detection limits predicted by the minimum detectable difference model were consistently lower than the used nominal detection limits. Second, the calibration model detection limits were, with rare exceptions, consistently higher than the nominal detection limits and tended to be overly conservative. The excessive conservatism is best illustrated in Table 1B in which the calibration model detection limits were on the average of 2X higher (which translated into usually > 2 ppb higher) than the nominal detection limits) even though all of the empirical data indicates that the nominal detection limits are less than 1 ppb lower than the true, < 1% false positive detection limits. In the few instances in which the calibration model predicted a lower detection limit than the nominal value, the compound was detectable at less than 0.5 ppb above the nominal detection limit. Third, the minimum detectable difference model may be adequate for predicting the rate of false positive (a supposition which was not tested) but fails to predict the probability of false negatives.

Conclusions

The nominal detection limits had an experimentally determined, conservative false negative rate of approximately 22% when compared against chlorotoluene calibration concentrations of less than 0.5 ppb above the used detection limit criteria. This rate was considered to be conservative because several of the observed false negatives could have been caused by errors in the spiked concentrations themselves and not in the observed signals. When the criteria were applied to concentration data obtained at 0.5 - < 1 ppb above the nominal detection limits, no false negatives were observed. Consequently two different detection limit models were evaluated for use with the data, the minimum detectable difference model (Zar, 1984) and the calibration curve model (Hubaux and Vos, 1968). Neither model compared favorably against the calibration data. The calibration model tended to be overly conservative and predicted detection limits at concentrations much higher than the TAGA was able to repeatedly detect compounds (> 0.5 ppb above the nominal detection limits). The minimum detectable difference model repeatedly underestimated the detection limits at which an analysts could have reasonable certainty that false negatives were not occurring.

References

Hubaux, Andre, and G. Vos; "Decision and Detection Limits for Linear Calibration Curves", Analytical Chemistry, 42:8, 849-855, (1968)

G.H. Zar; "Biostatistical Analysis, 2nd Edition", Prentice Hall, Inc., Englewood, NJ, 1984.

CH2M Hill, "Pilot Study for Love Canal EDA Habitability Study, Volume I", February 1987.

L.A. Currie; "Limits for Qualitative Detection and Quantitative Determination", Analytical Chemistry; 40:3, 586-593, (1968).

Origin of TAGA Performance Criteria, Artiola, pgs. 2, p. 6:

In his review of the QAPP, Dr. Artiola states that the criteria for the TAGA data quality objectives (DQOs) were not properly referenced or justified. In a similar manner Dr. Shy wanted further information on the selection of 4 ppb as the maximum acceptable detection limit. There were (and still are) no references upon which TAGA performance criteria could be based. The selection of 4 ppb as the maximum acceptable detection limit was based strictly upon the achievable detection limits of the TAGA and was not driven by a health based criteria (except that the DLs had to be as low as possible). All of the proposed DQO criteria were set after several months of TAGA method development during which the various instrument parameters were routinely monitored when the TAGA was known to be operating properly. These criteria were then reviewed and compared against the combined 8 years of direct TAGA experience (as of Spring 87) of the three senior TAGA scientists. During this review the only criticism of these criteria was that they were probably too tight; the TAGA could have difficulty consistently meeting these specifications in the field.

We have discussed these criteria with other TAGA groups since the QAPP was written and the field work initiated. These groups / operators included Raphe Pavlick - the Roy F. Weston TAGA operator from the several years that they marketed TAGA applications; Tye Willingham - a former operator of the EPA's TAGA and a current operator of the York Research TAGA; Sciex - the instrument manufacturer; and Ministry of the Environment, Ontario - the group operating the Canadian government's mobile TAGA. In all cases they were pleasantly surprised that the TAGA was indeed meeting such stringent criteria.

Interferences, Dr. Daisey p. 3:

Dr. Daisey asked how we determined that the ion pairs chosen were not subject to interferences. This determination was based upon three sets of data. First, during the combined 8 years of direct TAGA experience none of the senior TAGA scientists had ever encountered any compound except chlorobenzene and chlorotoluenes forming all three of either set of ion pairs. Second, none of the TAGA operators could hypothesize from their considerable GC/MS experience any organic compound which, for either set of ion pairs, could conceivably form both of the parent ions and then have that those parent ions fragment to the selected daughter ions. Third, because of the constant raising of this question (including at the last peer review committee / TRC meeting), during our months of method development/refinement we specifically looked for interferences to any of the selected compounds. In every case, whenever unexpected signals were seen for the selected ion pairs, the signals were found to be caused by real levels of the target compounds. In fact, several leaks in the TAGA inlet systems were discovered during this search for interferences. No true interferences were ever observed.

However, the interference issue is a moot point in regards to this study. Interferences can only affect the data quality by either biasing reported values high or causing false positives. Only three sets of positive unknown data were ever acquired during the study - two sets for the "detect" house and on set for ambient air. Had any of these "hits" been caused by an interferent, based upon our previous experiences with interferences with other compounds, the resulting individual ion pair concentrations would have been skewed. This was not the case for these three sets of data; the individual ion pair concentrations were consistent. In addition, the house detect was confirmed by a Summa canister grab sample followed by GC/MS analysis. Therefore, it is safe to state that there was never a problem due to interferences to the selected ion pairs for chlorotoluene, the only compound for which the issue of interferences would have been applicable in this study.

Calibrations in Ambient Air, Dr. Daisey p. 4:

Dr. Daisey asked whether ambient air was used during the TAGA calibrations and what the effect that contaminated ambient air would have had on the detection limits. Ambient air was used. If that ambient air was contaminated then the reported detection limits would have been biased high. During phases 3 & 4 we did encounter calibrations in which elevated I_0 signals for chlorotoluene were seen. Corrections to the detection limits were applied. This elevated signal determination and the applied corrections are covered in detail in my final summary of QAPP modifications memo dated April 15, 1988 and in my initial reply to the peer review comments dated May 19, 1988.

Typical Sequence of TAGA Events, Artiola p. 2:

Dr. Artiola stated that he found it difficult to discern in the QAPP the start-up and end-of-day procedures from those implemented prior to entering each house. This was partially due to the fact that several of the procedures (e.g., LCIC calibrations) were repetitively used throughout each sampling day. Another confusing procedure was the "Analysis Procedure for Precision / Performance Evaluation Cylinders/Canisters" (Section 4.7 of Appendix A). This procedure was used during both the start-of-day and end-of-day instrument checkouts - the only difference being which sample was being analyzed using this procedure (i.e., 6 Liter Summa canister, 16 Liter Summa canister, or Scott Specialty standard cylinder).

To clarify this confusion I have enclosed Table 2, which lists the typical TAGA analysis sequence for a given day. The table references the Appendix A section applicable to each sequence step. However, the table does not list the initial LCIC calibration which was required for the start-of-day Scott precision/P.E.

cylinder analysis because the procedure itself states that a prior calibration was required.

Auditing of TAGA Maintenance Logbook, Dr. Daisey p. 4:

Dr. Daisey asked whether the TAGA's maintenance logbook was ever audited. The logbook was audited by Ken Caviston of Northrop Services, the ORD Quality Assurance Branch operations contractor, prior to the first phase of the study. It was not re-audited afterwards.

Whenever TAGA maintenance or corrective actions were taken during a sampling phase, these actions were documented on the TAGA chronological logsheet for that day. In addition, the TAGA senior scientist kept a personal logbook in which he recorded all maintenance activities which occurred during each sampling period. Therefore all TAGA maintenance during this study was always recorded and was usually recorded in at least two separate sets of documents.

Typographical Errors in Appendix A of the QAPP, Dr. Daisey pgs. 3-4, Items 5, 6, and 10:

Dr. Daisey noted several items which she identified as either typographical or omission errors. These items were 1) "benzene" in line 5 of paragraph 1 of page 3-4 should be "benzyl"; 2) factor of 2 missing from equation 2, line 23 on page 4-12; and 3) E_C is not defined. On the first item she is correct - "benzene chloride" should be "benzyl chloride" (alpha-chlorotoluene).

However, on the second item she is not correct. The noted equation is a direct transcription of equation A.3.2 of Appendix A of the "Summary of the TAGA Standard Operating and Reporting Procedures for the Love Canal Full-Scale Air Sampling Study" (Appendix A of the QAPP). The issue of whether of factor of 2 should be included in the calculations is an issue of the degree of confidence one can place in the predicted errors bars. Since these error bars are not statistically derived, confidence intervals based upon standard deviations are not applicable. If factors are needed to define the confidence intervals for these error bars, these factors may ultimately be defined by both the time interval and the relative differences between the bracketing response factors. However, in this study these error bars would have been applied to data with temporally close, bracketing calibrations. Therefore, a factor of 2 would not have been applicable. In fact, during the instances when intermediate response factors would have been applicable (the "detect" house), the bracketing calibrations had response factors which were so similar that there was no significant difference between the concentrations calculated with either set of bracketing response factors and those calculated with intermediate response factors.

When Dr. Daisey made her comment on E_C she correctly identified E_C as the uncertainty in the reported concentration. Although E_C was not defined in the text, it was mathematically defined in equation A.2.3. The confusion arose because of the use of the ≡ symbol in the equation. When this symbol is used in mathematical derivations it is used to specify that the variable to the left of the symbol is "defined as" the expression to the right of the symbol. In writing this derivation I assumed that the readers would be familiar with the meaning of the ≡ symbol.

Effect of Changes in Humidity on TAGA Sensitivity

In controlled experiments performed at Edison the maximum decrease in TAGA sensitivity under maximum shifts of relative humidity (dry zero air to near-saturation) never exceeded a factor of 2. On two separate days the TAGA sensitivity was evaluated in controlled humidity matrices ranging from dry zero air to essentially saturated zero air. The results were reproducible and the relative changes in instrument response were consistent over a 5X range of concentrations. A typical set of relative response versus absolute humidity data is illustrated in Figure 1. (The high humidity reading is biased low by the inaccuracy of the relative humidity probe at close to the saturation point.)

The TAGA's sensitivity was always highest with zero air (no humidity) and suffered the largest relative drop when the sample air was initially humidified. Therefore the effects of humidity changes on the detection limits for the EDA houses should always be less than a factor of two because there must always be some humidity in the ambient and indoor air.

cc: B. Coakley, U.S. EPA-ERT
G. Helms, CH2M Hill
D. Mickunas, Roy F. Weston, Inc. (REAC)

FIGURE 1. RELATIVE SENSITIVITY OF TAGA

FOR LCICs Vs. ABSOLUTE HUMIDITY

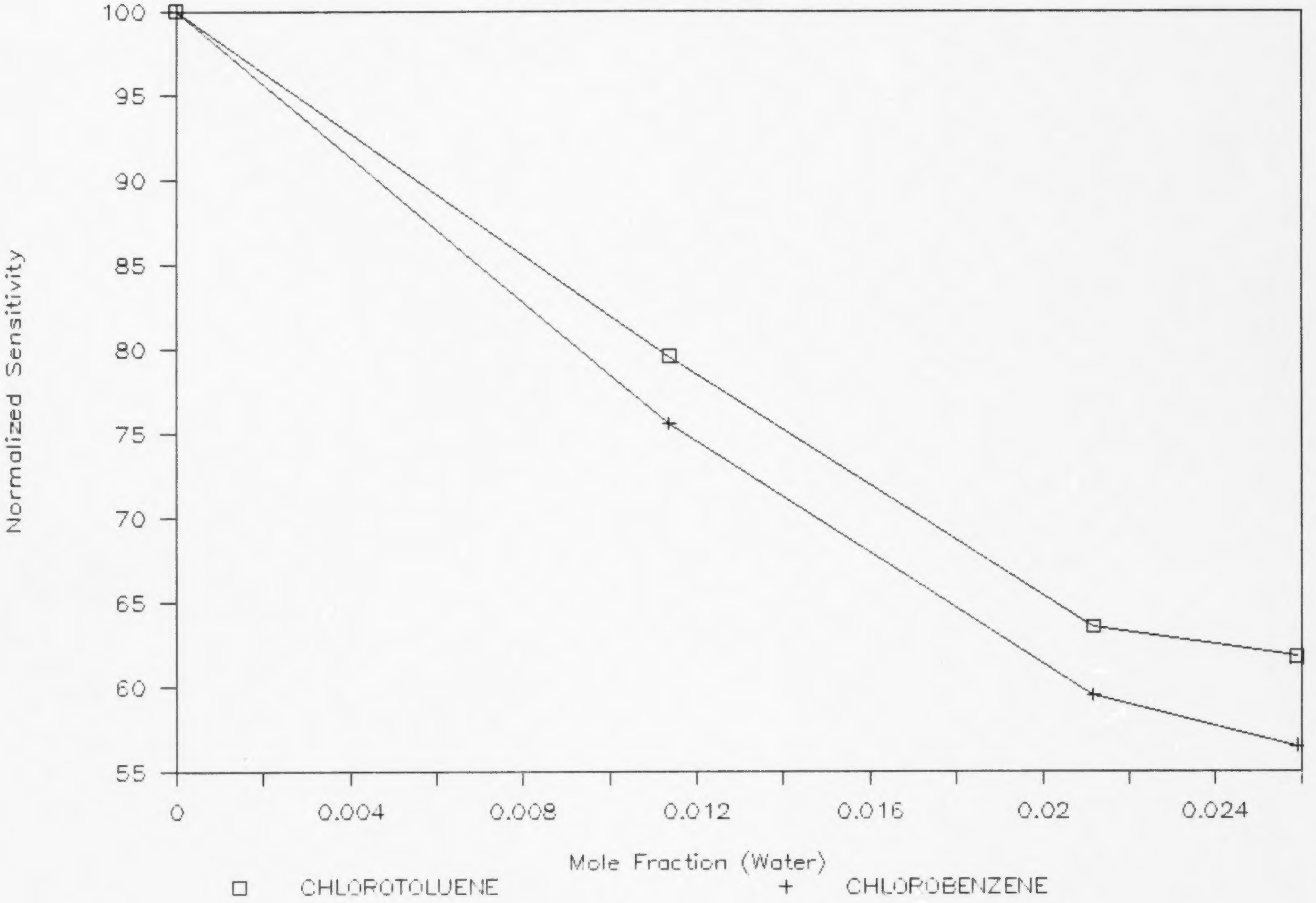


TABLE 1A. RESULTS FROM CHLOROTOLUENE CALIBRATIONS IN WHICH A CONCENTRATION LESS THAN 0.5 PPB FAILED ONE OR "DETECT" CRITERIA (FALSE NEGATIVE).

FILE NAME	NOMINAL DETECTION LIMIT (PPB)	SPIKED CONC. (PPB)	SIGNAL DETECTION LIMIT (ICPS)	OBSERVED SIGNAL (ICPS)	PPB EQUIV. OF DIF.	TOTAL PPB ADJUSTMENT TO DL
MLC046	1.9	2.0	214	186	0.2	0.3
MLC088	1.8	2.1	187	166	0.2	0.5
MLC150 (I)	3.9	4.0	566	392	1.2	1.3
MLC150 (S)	3.9	4.0	149	136	0.3	0.4
MLC158 (I)	1.9	2.0	206	151	0.5	0.6
MLC158 (S)	1.9	2.0	53	52	0.0	0.1
MLC003 (I)	2.0	2.0	261	179	0.6	0.6
MLC003 (S)	2.0	2.0	93	84	0.2	0.2
MLC002	1.8	1.9	236	235	0.0	0.1
MLC035	1.9	2.0	205	202	0.0	0.1
MLC2081	2.0	2.0	96	79	0.4	0.4
MLC3138	2.0	2.1	149	136	0.2	0.3
MLC114 (I)	1.8	2.0	238	178	0.5	0.7
MLC114 (S)	1.8	2.0	76	74	0.0	0.2

NOTES:

Unless noted otherwise, the Chlorotoluene was not detected because the signal of the most sensitive ion did not meet the identification criteria unless designated otherwise by suffices after the file name. When the chlorotoluene was missed because of an ion signal did not meet its 2 sigma limit, then the different signals are noted as (I) and (S) for ID criteria and ion signal criteria, respectively.

TABLE 18. COMPARISON OF VARIOUS DETECTION LIMITS WITH CALIBRATION DATA IN WHICH BOTH LCICs WERE "DETECTED" IN WHICH BOTH LCICs WERE "DETECTED" AT CONCENTRATIONS 0.5 - < 1 PPB OF THE NOMINAL DETECTION LIMITS.

	CHLOROTOLUENE						CHLOROBENZENE					
FILE	SPIKED CONC.	NOMINAL Det Lim	MOD DL (1)	% DIF. FROM NOMINAL Det Lim	MAX. DL FROM CALIB (2)	PPB DIF. FROM NOMINAL Det Lim	SPIKED CONC.	NOMINAL Det Lim	MOD DL (1)	% DIF. FROM NOMINAL Det Lim	MAX. DL FROM CALIB (2)	PPB DIF. FROM NOMINAL Det Lim
MLC4119	2.1	1.6	1.1	-31.3%	5.2	3.6	2.1	1.4	0.8	-42.9%	3.4	2.0
MLC042	2.0	1.5	0.7	-53.3%	3.2	1.7	2.0	1.3	0.6	-53.8%	3.3	2.0
MLC012	2.0	1.4	0.7	-50.0%	6.6	5.2	2.0	1.5	0.6	-60.0%	9.9	8.4
MLC4040	2.0	1.4	0.9	-35.7%	4.1	2.7	2.0	1.2	0.8	-33.3%	4.4	3.2
MLC4037	2.0	1.4	1.0	-28.6%	3.0	1.6	2.0	1.2	0.7	-41.7%	3.8	2.6
MLC4043	2.0	1.3	1.5	15.4%	5.1	3.8	2.0	1.5	0.7	-53.3%	4.2	2.7
MLC178	2.1	1.3	0.6	-53.8%	5.5	4.2	2.1	1.2	0.5	-58.3%	3.8	2.6
MLC076	2.0	1.3	0.7	-46.2%	5.6	4.3	2.0	1.2	0.6	-50.0%	3.6	2.4
MLC4124	2.1	1.3	0.9	-30.8%	1.6	0.3	2.1	1.1	0.7	-36.4%	1.8	0.7
MLC010	1.9	1.2	0.6	-50.0%	2.8	1.6	1.9	1.3	0.7	-46.2%	2.1	0.8
AVERAGE	-	-	-	-36.4%	-	2.9	-	-	-	-47.6%	-	2.7

NOTES:

(1) - Detection limit based upon minimum detectable difference with the least sensitive ion pair.
(2) - Maximum of the ion pair detection limits calculated from the calibrations using method developed by Hubaux and Vos.

TABLE 1C. COMPARISON OF VARIOUS DETECTION LIMITS WITH CALIBRATION DATA IN WHICH CHLOROTOLUENE WAS "DETECTED" AT A CONCENTRATION LESS THAN 0.5 PPB OF THE NOMINAL DETECTION LIMIT.

FILE	SPIKED CONC.	NOMINAL Det Lim	MDD DL (1)	MAX. DL FROM CALIB (2)	% SPIKED ABOVE THE "DETECTION LIMIT" NOMINAL Det Lim	MDD DL (1)	MAX. DL FROM CALIB (2)
MLC008	1.9	1.9	0.8	4.1	0.0%	137.5%	-53.7%
MLC032	1.9	1.9	0.9	1.5	0.0%	111.1%	26.7%
MLC3143	2.1	2.0	1.2	3.4	5.0%	75.0%	-38.2%
MLC4151	2.0	1.9	1.1	1.2	5.3%	81.8%	66.7%
MLC3134	2.1	1.9	1.3	2.6	10.5%	61.5%	-19.2%
MLC4133	2.0	1.8	1.0	1.7	11.1%	100.0%	17.6%
MLC2126	2.0	1.8	0.7	2.7	11.1%	185.7%	-25.9%
MLC2086	2.0	1.7	1.0	3.1	17.6%	100.0%	-35.5%
MLC3021	2.1	1.7	1.0	2.9	23.5%	110.0%	-27.6%
AVERAGE	-	-	-	-	9.4%	107.0%	-9.9%

NOTES:

(1) - Detection limit based upon minimum detectable difference with the least sensitive ion pair.

(2) - Maximum of the ion pair detection limits calculated from the calibrations using the method developed by Hubaux and Vos.

TABLE 1D. COMPARISON OF VARIOUS DETECTION LIMITS WITH CALIBRATION DATA IN WHICH CHLOROTOLUENE WAS "NOT DETECTED" AT A CONCENTRATION LESS THAN 0.5 PPB OF THE NOMINAL DETECTION LIMIT (FALSE NEGATIVE).

					% SPIKED ABOVE THE "DETECTION LIMIT"		
FILE	SPIKED CONC.	NOMINAL Det Lim	MDD DL (1)	MAX. DL FROM CALIB (2)	NOMINAL Det Lim	MDD DL (1)	MAX. DL FROM CALIB (2)
MLC2081	2.0	2.0	1.3	4.2	0.0%	53.8%	-52.4%
MLC003	2.0	2.0	0.6	6.3	0.0%	233.3%	-68.3%
MLC150	4.0	3.9	1.0	9.5	2.6%	300.0%	-57.9%
MLC3138	2.1	2.0	1.2	4.4	5.0%	75.0%	-52.3%
MLC046	2.0	1.9	0.9	6.8	5.3%	122.2%	-70.6%
MLC035	2.0	1.9	0.8	3.6	5.3%	150.0%	-44.4%
MLC158	2.0	1.9	0.9	5.5	5.3%	122.2%	-63.6%
MLC002	1.9	1.8	0.7	4.8	5.6%	171.4%	-60.4%
MLC114	2.0	1.8	0.7	5.4	11.1%	185.7%	-63.0%
MLC088	2.1	1.8	0.8	6.7	16.7%	162.5%	-68.7%
AVERAGE	-	-	-	-	5.7%	157.6%	-60.2%

NOTES:

(1) - Detection limit based upon minimum detectable difference with the least sensitive ion pair.

(2) - Maximum of the ion pair detection limits calculated from the calibrations using the method developed by Hubaux and Vos.

TABLE II. TAGA DAILY OPERATIONS SUMMARY

1. Completed TAGA operating log sheet (SORP figure 4.1.1)

2. Started and warmed up instrument (SORP section 4.1) and completed checklist (SORP figure 4.1.4)

3. Performed mass calibration of quadrupoles 1 and 3 (SORP section 4.1).

4. Performed Scott precision/p.e. cylinder analysis (SORP section 4.7)

5. Performed hose transportation efficiency verification (SORP section 4.2)

6. Performed compound calibration immediately prior to sampling house (SORP section 4.3) and checked response factor decay and detection limits.

7. Analyzed house (SORP section 4.6)

8. Repeated sections 6 and 7 until the end of the day.

9. Performed the end of day compound calibration (SORP section 4.3)

10. Performed the detection and quantization limit verification analysis (SORP section 4.8)

11. Performed the 16-l precision/p.e. summa canister analysis (SORP section 4.7; the frequency of this analysis varied according to canister availability and Q.C requirements)

12. Performed the 6-l p.e. summa canister analysis (SORP section 4.7; the frequency of this analysis varied according to canister availability and Q.C. requirements)

13. Performed the end of day hose transportation efficiency verification analysis (SORP section 4.2)

14. Shut down instrument and recycled cryosystem

APPENDIX C
Memorandum:
Reply to Peer Review Comments,
May 19, 1988

Air Assessment--Indicator Chemicals

Prepared by

U.S. EPA Environmental Response Branch
Environmental Response Team
Edison, New Jersey

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
EDISON, NEW JERSEY 08837

May 19, 1988

MEMORANDUM

SUBJECT: Reply to Peer Review Comments on the Love Canal Emergency Declaration Area Full Air Study

FROM: Thomas H. Pritchett, ERT QA/QC Coordinator (Love Canal)
Environmental Response Branch

TO: Doug Garbarini
Love Canal EDA Habitability Study Project Manager
U.S. EPA Region II, ERRD-NYCRA

I have read the four sets of peer review comments that I received and have verbally responded to questions from Dr. Schoenfield over the phone. In these comments and questions two major issues directly related to the TAGA arose which I should address.

The first issue, which was raised by both Dr. Daisey and Dr. Schoenfield, concerned our use of I_0 to calculate the detection limits when the calibrations were performed in ambient air. Both noticed that this method assumes that no LCICs or interferences are present during the calibration. They both questioned the validity of that assumption and correctly identified the potential for an artificial positive bias in the detection limits if either an LCIC or interferent was present. Dr. Schoenfield was specifically worried that this bias could result in the occurrence of false negatives. As I explained to Dr. Schoenfield, we were aware of that potential and watched for elevated I_0signals during the calibrations. Elevated I_0 signals for chlorotoluene were observed five times during phase 3 and ten times in phase 4; none were observed for chlorobenzene. Whenever an elevated I_0 was observed, an alternate set of detection limits were computed using the procedures outlined on page 9 of in the "Final Summary of Modifications to TAGA Procedures Used During the Love Canal Full-Scale Air Sampling Study", dated April 15, 1988 and the occurrences were documented with ERT QA/QC memoranda to the files. These memoranda are contained within the TAGA group's final report and are specifically referenced in report as Memo #s T, U, and Z. In all cases the initial non-detect field determination remained unchanged. Therefore, this potential biases towards false negatives was checked for and, in the very few cases in which it could have occurred, it was never found.

The second issue concerned the variability in the TAGA's detection limits and the effect that this variability would have on comparisons of this data to past air data and to the habitability criteria. The peer reviewers did not have the full set of data (specifically the detection limits for each house) from which they could compute the statistical summaries needed to answer their concerns. These I have enclosed. Specifically Table 1 lists by phase the following detection limit data for both compounds: the average, the standard deviation, the minimum value used, and the maximum value used. (When the original detection limit was based upon an artificially high IO, I used the alternate detection limit in computing these statistics.) The attached figures graphically illustrate the frequency at which a given range of detection limits were used for each phase and for the whole study. Because these distributions are not Gaussian, I have also summarized the detection limit distribution in Table 2.

I have only addressed the TAGA-related concerns of which I am aware of. As additional concerns are raised either by the remaining reviewers or during a TRC meeting, I will be happy to make the appropriate reply.

Attachment

cc: B. Coakley, U.S. EPA-ERT
G. Helms, CH2M Hill ✓

TABLE 1. SUMMARY OF DETECTION LIMITS USED FOR HOUSE ANALYSES DURING THE LOVE CANAL EDA FULL AIR STUDY

	Chlorobenzene	Chlorotoluene
PHASE 1	N = 129	
AVERAGE DETECTION LIMIT (ppb)	1.04	1.23
STANDARD DEVIATION (ppb)	0.46	0.54
MINIMUM DETECTION LIMIT	0.50	0.60
MAXIMUM DETECTION LIMIT	3.70	4.20
PHASE 2	N = 133	
AVERAGE DETECTION LIMIT (ppb)	0.69	0.81
STANDARD DEVIATION (ppb)	0.22	0.29
MINIMUM DETECTION LIMIT	0.40	0.40
MAXIMUM DETECTION LIMIT	1.60	2.30
PHASE 3	N = 148	
AVERAGE DETECTION LIMIT (ppb)	0.88	1.17
STANDARD DEVIATION (ppb)	0.24	0.36
MINIMUM DETECTION LIMIT	0.50	0.60
MAXIMUM DETECTION LIMIT	1.80	2.70
PHASE 4	N = 155	
AVERAGE DETECTION LIMIT (ppb)	0.70	0.93
STANDARD DEVIATION (ppb)	0.20	0.28
MINIMUM DETECTION LIMIT	0.40	0.40
MAXIMUM DETECTION LIMIT	1.50	2.10
SUMMARY	N = 565	
AVERAGE DETECTION LIMIT (ppb)	0.82	1.03
STANDARD DEVIATION (ppb)	0.32	0.42
MINIMUM DETECTION LIMIT	0.40	0.40
MAXIMUM DETECTION LIMIT	1.50	2.10

TABLE 2. FREQUENCY DISTRIBUTION FOR THE TAGA DETECTION LIMITS USED
DURING THE LOVE CANAL EPA FULL-SCALE AIR SAMPLING STUDY

	PHASE 1				PHASE 2				PHASE 3				PHASE 4				FOR ALL PHASES			
	CHLOROBENZENE		CHLOROTOLUENE		CHLOROBENZENE		CHLOROTOLUENE		CHLOROBENZENE		CHLOROTOLUENE		CHLOROBENZENE		CHLOROTOLUENE		CHLOROBENZENE		CHLOROTOLUENE	
DL	Freq	Per.	Freq	Per.	Freq	Per.	Freq	Per.	Freq	Per.	Freq	Per.	Freq	Per.	Freq	Per.	Freq	Per.	Freq	Per.
0.4	0	0.0%	0	0.0%	2	1.5%	1	0.8%	0	0.0%	0	0.0%	12	7.7%	1	0.6%	14	2.5%	2	0.4%
0.5	1	0.8%	0	0.0%	25	20.3%	8	6.8%	9	6.1%	0	0.0%	25	23.9%	8	5.8%	60	13.1%	16	3.2%
0.6	9	7.8%	3	2.3%	46	54.9%	27	27.1%	18	18.2%	5	3.4%	30	43.2%	19	18.1%	103	31.3%	54	12.7%
0.7	17	20.9%	6	7.0%	30	77.4%	40	57.1%	20	31.8%	8	8.8%	37	67.1%	20	31.0%	104	49.7%	74	25.8%
0.8	0	20.9%	0	7.0%	0	77.4%	0	57.1%	0	31.8%	0	8.8%	0	67.1%	0	31.0%	0	49.7%	0	25.8%
0.9	22	38.0%	16	19.4%	14	88.0%	19	71.4%	22	46.6%	9	14.9%	21	80.6%	16	41.3%	79	63.7%	60	36.5%
1.0	20	53.5%	14	30.2%	3	90.2%	12	80.5%	27	64.9%	21	29.1%	17	91.6%	21	54.8%	67	75.6%	68	48.5%
1.1	19	68.2%	20	45.7%	3	92.5%	10	88.0%	17	76.4%	19	41.9%	5	94.8%	22	69.0%	44	83.4%	71	61.1%
1.2	14	79.1%	28	67.4%	4	95.5%	5	91.7%	27	94.6%	37	66.9%	6	98.7%	27	86.5%	51	92.4%	97	78.2%
1.3	8	85.3%	8	73.6%	2	97.0%	1	92.5%	4	97.3%	8	72.3%	0	98.7%	12	94.2%	14	94.9%	29	83.4%
1.4	4	88.4%	7	79.1%	0	97.0%	1	93.2%	1	98.0%	11	79.7%	0	98.7%	3	96.1%	5	95.8%	22	87.3%
1.5	6	93.0%	4	82.2%	2	98.5%	6	97.7%	1	98.6%	11	87.2%	2	100.0%	2	97.4%	11	97.7%	23	91.3%
1.6	1	93.8%	5	86.0%	2	100.0%	1	98.5%	1	99.3%	5	90.5%	0	100.0%	1	98.1%	4	98.4%	12	93.5%
1.7	4	96.9%	2	87.6%	0	100.0%	0	98.5%	0	99.3%	4	93.2%	0	100.0%	1	98.7%	4	99.1%	7	94.7%
1.8	0	96.9%	3	89.9%	0	100.0%	0	98.5%	1	100.0%	1	93.9%	0	100.0%	1	99.4%	1	99.3%	5	95.6%
1.9	0	96.9%	4	93.0%	0	100.0%	0	98.5%	0	100.0%	2	95.3%	0	100.0%	0	99.4%	0	99.3%	6	96.6%
2.0	0	96.9%	1	93.8%	0	100.0%	1	99.2%	0	100.0%	3	97.3%	0	100.0%	0	99.4%	0	99.3%	5	97.5%
2.1	1	97.7%	0	93.8%	0	100.0%	0	99.2%	0	100.0%	3	99.3%	0	100.0%	1	100.0%	1	99.5%	4	98.2%
2.2	0	97.7%	2	95.3%	0	100.0%	0	99.2%	0	100.0%	0	99.3%	0	100.0%	0	100.0%	0	99.5%	2	98.6%
2.3	0	97.7%	1	96.1%	0	100.0%	1	100.0%	0	100.0%	0	99.3%	0	100.0%	0	100.0%	0	99.5%	2	98.9%
2.4	0	97.7%	0	96.1%	0	100.0%	0	100.0%	0	100.0%	0	99.3%	0	100.0%	0	100.0%	0	99.5%	0	98.9%
2.5	0	97.7%	2	97.7%	0	100.0%	0	100.0%	0	100.0%	0	99.3%	0	100.0%	0	100.0%	0	99.5%	2	99.3%
2.6	0	97.7%	0	97.7%	0	100.0%	0	100.0%	0	100.0%	0	99.3%	0	100.0%	0	100.0%	0	99.5%	0	99.3%
2.7	0	97.7%	1	98.4%	0	100.0%	0	100.0%	0	100.0%	1	100.0%	0	100.0%	0	100.0%	0	99.5%	2	99.6%
2.8	0	97.7%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.5%	0	99.6%
2.9	0	97.7%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.5%	0	99.6%
3.0	0	97.7%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.5%	0	99.6%
3.1	1	98.4%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	1	99.6%	0	99.6%
3.2	1	99.2%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	1	99.8%	0	99.6%
3.3	0	99.2%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.8%	0	99.6%
3.4	0	99.2%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.8%	0	99.6%
3.5	0	99.2%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.8%	0	99.6%
3.6	0	99.2%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.8%	0	99.6%
3.7	1	100.0%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	1	100.0%	0	99.6%
3.8	0	100.0%	0	98.4%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.6%
3.9	0	100.0%	1	99.2%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	1	99.8%
4.0	0	100.0%	0	99.2%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.8%
4.1	0	100.0%	0	99.2%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	99.8%
4.2	0	100.0%	1	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	0	100.0%	1	100.0%

Notes:

DL - Detection limit in ppb(v)
Freq. - Number of houses with which the detection limit was used.
Per. - The percent of houses with which a detection limit less than or equal to the value at the left.

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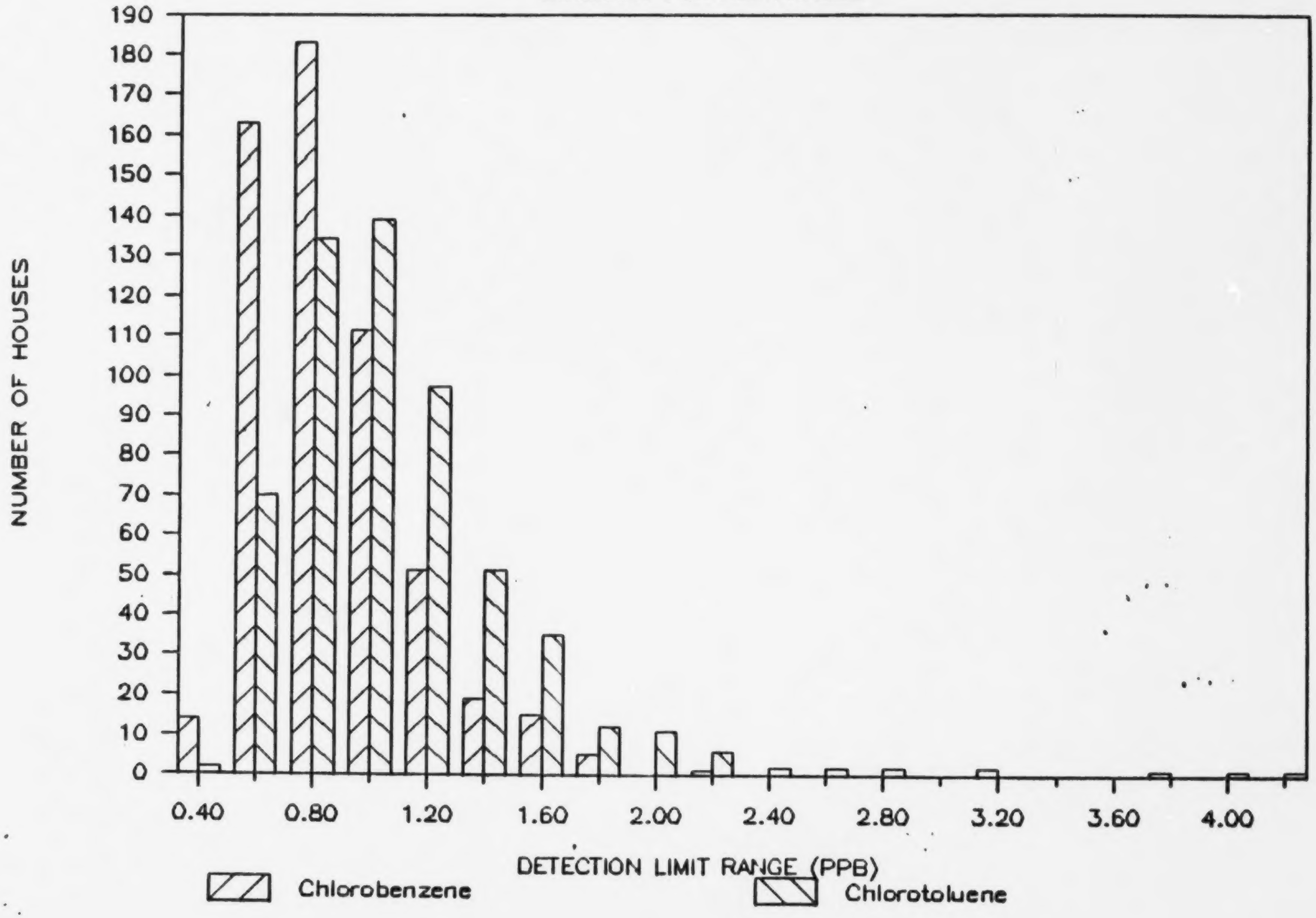
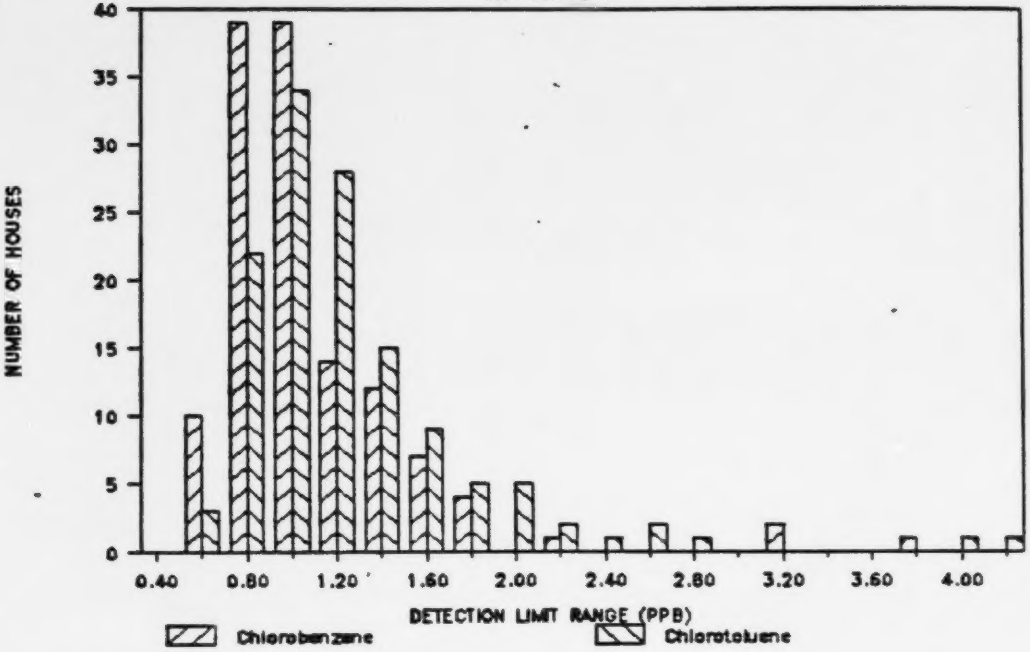
FREQUENCY DISTRIBUTION OF USED DLs

SUMMARY FOR ALL PHASES



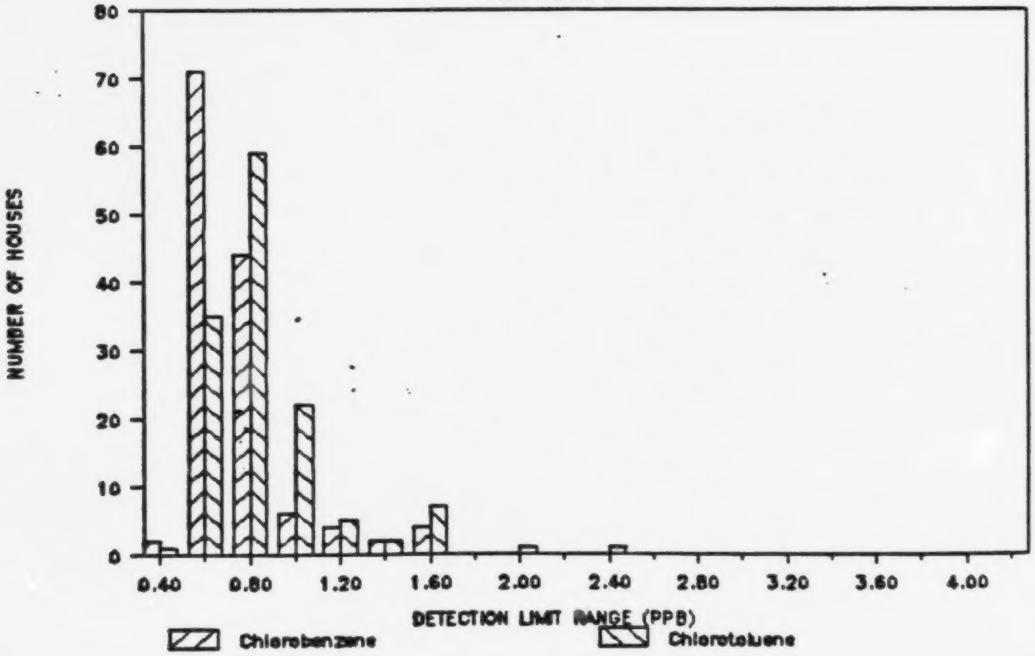
FREQUENCY DISTRIBUTION OF USED DLs

FOR PHASE 1



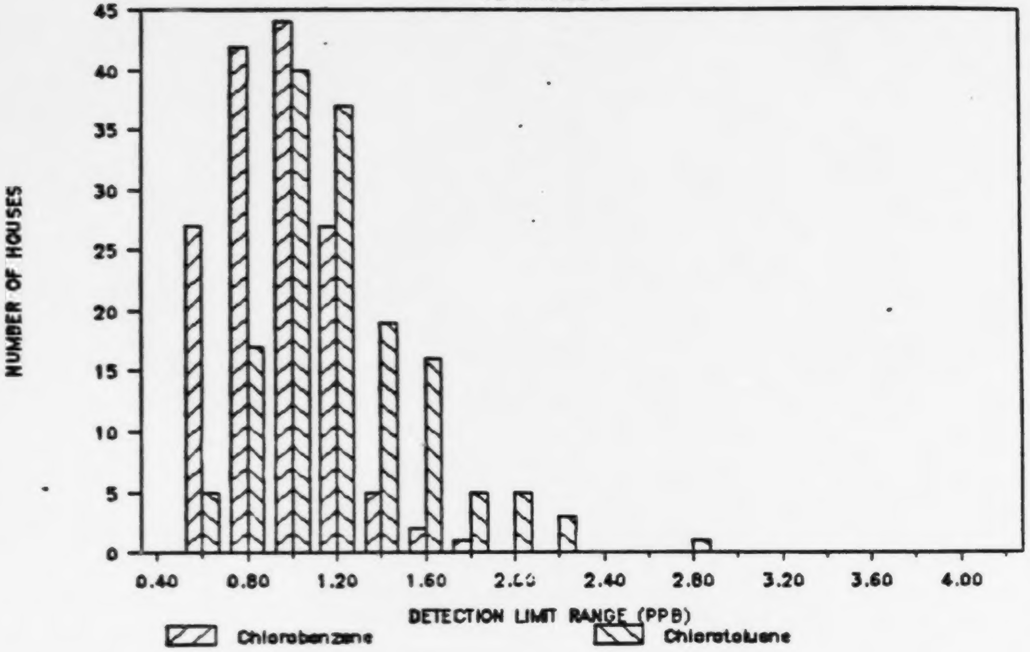
FREQUENCY DISTRIBUTION OF USED DLs

FOR PHASE 2



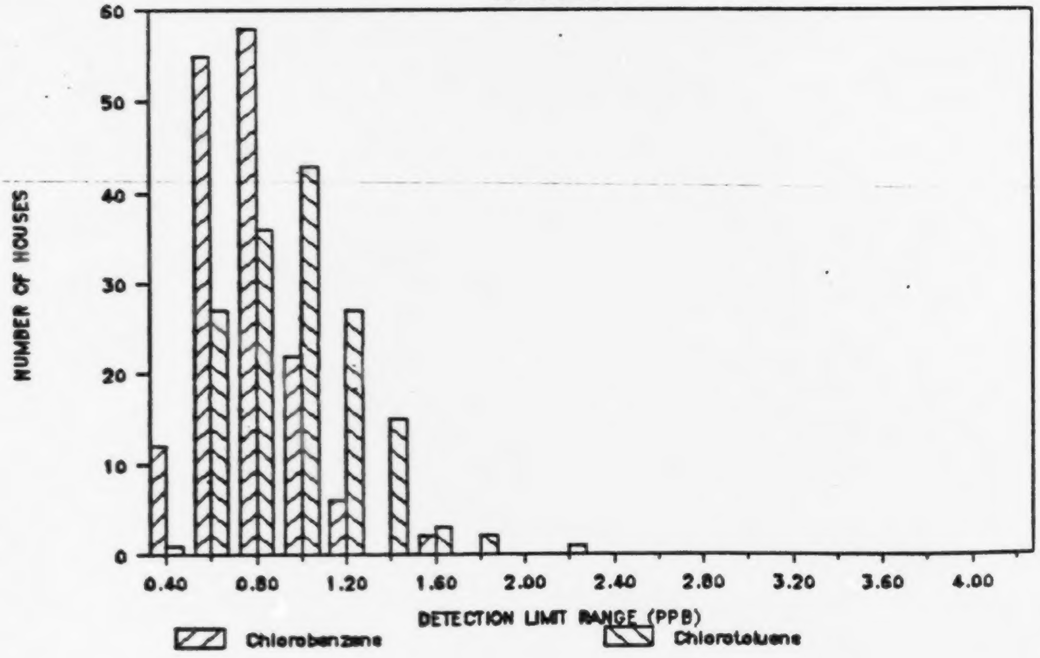
FREQUENCY DISTRIBUTION OF USED DLs

FOR PHASE 3



FREQUENCY DISTRIBUTION OF USED DLs

FOR PHASE 4



APPENDIX D

Reasons for Denial of Permission to Sample Love Canal Properties

Love Canal EDA Habitability Study

Prepared by

New York State Department of Health
Albany, New York

STATE OF NEW YORK - DEPARTMENT OF HEALTH

INTEROFFICE MEMORANDUM

TO: Tim Van Epp
CH2M Hill

FROM: Edward G. Horn, Ph.D., Environmental Scientist
Division of Environmental Health Assessment

SUBJECT: Reasons for Denial of Permission to Sample Love Canal Properties

DATE: June 14, 1988

The attached tables were prepared in response to a request by peer reviewers of the Love Canal Emergency Declaration Area Habitability Study for the reasons that homeowners and residents of the Emergency Declaration Area denied permission to take samples from their property.

The two tables summarize what information could be found for the Air Assessment of Indicator Chemicals (samples taken in homes) and for the Soil Assessment of 2,3,7,8-TCDD. The reasons for denial of permission were ascertained at the time through follow-up phone calls and, in some cases, personal visits.

The Soil Assessment of Indicator Chemicals did not require the same follow-up because the random selection of 50 or 75 samples per sampling area did not necessitate maximum participation of homeowners. A summary of permissions and denials could not be prepared in the time available. However, the same individuals were involved as were in the Air Assessment, and no significant number of additional denials were encountered in the Soil Assessment of Indicator Chemicals.

Ed Horn

Attachment

cc: William Stasiuk
Doug Garbarini, EPA Region II

DIOXIN SAMPLING
REASONS FOR REFUSING PERMISSION

Reason	Number of times
Reason unknown/ No response to mailing*	15
Responded "no" to participation and asked not to be contacted again	1

* Property owners were contacted at least once by mail, and follow-up was done by phone or mail as needed. Persons not responding to the first mailing were either telephoned or mailed a follow-up before the end of the sampling program.

One owner refused to participate but two samples were taken from his lot in error.

One owner originally refused to participate due to concern over his lawn being damaged but later allowed sampling.

Sixteen owners were opposed to the study, its purpose and its costs but sold to LCARA before sampling ended. Samples were then collected on these properties.

These 18 instances are not reflected in the above count.

NYSDOH
14 June 1988

AIR SAMPLING
REASONS FOR REFUSING PERMISSION

Reason		Number of homes
Permission refused		
Reasons unknown (No Response to mail and phone inquiries)*		9
Owner said no but didn't state a reason		8
Owner said yes but tenant refused access		3
Tenant opposed to study	1	
Tenant reasons unknown	2	
Husband said yes but wife refused for housecleaning reasons		3
Concerns about integrity of sampling team		2
Owner said no, house was tested enough		2
Home not accessible		
Structure physically inaccessible		4
Scheduling problems (resident couldn't be be there at stated times)		2
Unable to coordinate access for unoccupied building		1
Owner died and no contact existed for estate		1

* People were contacted at least twice by mail in every instance, and telephone follow-up was always attempted. When telephone outreach was unsuccessful, the sampling team was asked to leave a note for the resident or try to talk to them personally.

One person refused sampling due to concern that chemicals would be detected; but she reconsidered and a sample was taken.

Some residents refused access because they were opposed to the study, but they sold to LCARA in time for LCARA to allow air sampling.

These two instances are not reflected in the above count.

NYSDOH
14 June 1988

APPENDIX E
List of Errata

Air Assessment--Indicator Chemicals

Appendix E
LIST OF ERRATA
AIR ASSESSMENT--INDICATOR CHEMICALS

One erratum was identified that involves a change in content to Volume II. This erratum is defined below.

ERRATUM

The air assessment report incorrectly stated the analytic results of the sampling during Phase 2 of the house where CT was detected. The following text should be changed:

Page	Line	Erratum
1-2	27	"in the basement samples collected, suggesting" should read "in the basement samples collected during the initial sampling and investigation, suggesting"
1-2	15-17	"during Phase 2 of the study, chlorotoluene was detected on the main floor of the unoccupied, single-story structure in Neighborhood 6. The highest concentration detected was 3.4 ppb" should read "during Phase 2 of the study chlorotoluene was detected in an unoccupied, single-story structure in Neighborhood 6. During the initial sampling and investigation chlorotoluene was only detected on the main floor of the home. Lower levels of chlorotoluene were detected both on the main floor and in the basement during the home's second sampling in Phase 2. The highest concentration detected was 3.4 ppb on the main floor during the home's initial sampling."
6-11	20	"Chlorotoluene was not detected in the basement." should read "Chlorotoluene was not detected in the basement during this initial sampling and investigation."
6-11	26	"Levels in all six of the first floor rooms were between the quantitation and" should read "levels in the main floor and the basement were between the quantitation and"
6-11	29	"This investigation did not detect chlorotoluene in the air in the basement of the home during either sampling effort" should be deleted.

WDR358/052

6-11	26	"Levels in all six of the first floor rooms were between the quantitation and" should read "levels in the main floor and the basement were between the quantitation and"
6-11	29	"This investigation did not detect chlorotoluene in the air in the basement of the home during either sampling effort" should be deleted.

WDR358/052

APPENDIX F
Justification for Nonparametric Statistical Comparisons

Soil Assessment--Indicator Chemicals

Appendix F
JUSTIFICATION FOR NONPARAMETRIC STATISTICAL COMPARISONS
SOIL ASSESSMENT--INDICATOR CHEMICALS

In response to discussions with Dr. Stoline during the peer review of Volume III, a summary of the reasons for using nonparametric statistics for the analysis of the soil assessment for LCIC data has been prepared. This summary recapitulates discussions in the proposed habitability criteria document (NYSDOH and DHHS/CDC, 1986), the pilot study for soil LCIC (CH2M HILL, 1987) and the peer review of the pilot study for soil LCIC (Life Systems, 1987).

APPROACH

Following the recommendations of the Love Canal Emergency Declaration Area; Proposed Habitability Criteria (NYSDOH and DHHS/CDC, 1986) and the Peer Review of the Love Canal Full-Scale Sampling Plan (Life Systems, 1987), the goal of the soil assessment for indicator chemicals was to design and implement a sampling program that would achieve a 90 percent power of detecting an order-of-magnitude difference between an EDA sampling area and a comparison area with 95 percent confidence. The design of the soil assessment was thus centered around a statistical comparison approach.

Statistical methods can be broadly divided into two groups: parametric and nonparametric. Parametric methods require knowledge (or an assumption) about the statistical distribution that generated the data; nonparametric methods do not. The disadvantage of nonparametric methods is that they can be less powerful than parametric methods in cases where the assumptions of the parametric methods hold. The Wilcoxon rank sum test (a nonparametric test), however, is practically as powerful as the t-test (a parametric test) for the two-sample comparison problem under the normal distribution, equal variance assumptions required by the t-test; the power is 95 percent of the t-test (Lehmann, 1975, pp. 76-81).

If the assumptions required by a parametric test do not hold, the true alpha-level of the parametric test (the probability of incorrectly declaring the EDA sampling area to be different from the comparison area) can be grossly different from the assumed alpha-level, rendering the statistical results invalid. On the other hand, the alpha-level of a nonparametric test does not depend on the underlying distribution.

Two-sample parametric tests are usually designed to detect specific kinds of differences between two different distributions, such as location shifts, scale shifts, multiplicative shifts, or upper tail shifts. Although nonparametric tests are often used with a specific kind of shift in mind, they can be effective at detecting other kinds of shifts as well.

The LCIC data from both the pilot study and the full-scale study display two important characteristics that must be accounted for by any statistical method used to perform the comparisons:

- The distribution of the concentration estimates in most sampling areas are skewed to the right. The concentration estimates are bounded below by zero and exhibit a few very large values.

- The number of non-detect concentrations for some LCICs is quite large.

The major arguments for using a nonparametric method, as opposed to a parametric method, for performing the statistical comparisons can be summarized as follows:

1. The LCIC data do not conform to a normal distribution, which is the usual distribution assumed for parametric tests.

2. Although some transformation (e.g., natural logarithm) of the LCIC data may induce a distribution that approximates a normal distribution, the question remains as to how to deal with non-detects (since a non-detect cannot necessarily be assumed to equal zero or any other arbitrarily chosen value). Several methods are suggested in the literature for dealing with non-detects, which includes Gilbert and Kinnison (1981), Gillion and Helsel (1986), Gleit (1985), and Owen and DeRouen (1980). No method, however, is universally accepted.

3. A Monte Carlo simulation performed during the design of the sampling program and described in Appendix B of Volume III showed that a nonparametric test--the Wilcoxon rank sum test--gave the best performance in terms of power and maintenance of the nominal alpha-level over a wide range of distributions, censoring percentages, and sample sizes.

REFERENCES

CH2M HILL, 1987. Pilot Study for Love Canal EDA Habitability Study. Volumes I and II.

Gilbert, R.O. and Kinnison, R.R. 1981. "Statistical Methods for Estimating the Mean and Variance From Radionuclide Data Sets Containing Negative, Unreported, or Less-Than Values," Health Physics, 40, 377-390.

Gilliom, R.J., and Helsel, D.R. 1986. "Estimation of Distributional Parameters for Censored Trace Level Water Quality Data, 1, Estimation Techniques," Water Resources Research, 22, 135-146.

Gleit, A. 1985. "Estimation for Small Normal Data Sets With Detection Limits," Environmental Science and Technology, 19, 1201-1206.

Lehmann, E.L. 1975. Nonparametrics: Statistical Methods Based on Ranks. Holden-Day, San Francisco.

Life Systems. 1987. Peer Review of the Love Canal Full-Scale Sampling Plan.

NYSDOH and DHHS/CDC. 1986. Love Canal Emergency Declaration Area; Proposed Habitability Criteria.

Owen, W.J., and DeRouen, T.A. 1980. "Estimation of the Mean For Lognormal Data Containing Zeroes and Left-Censored Values, With Application to the Measurement of Worker Exposure to Air Contaminants," Biometrics, 36, 707-719.

WDR361/030

APPENDIX G
Empirical and Fitted Distribution of LCICs by EDA Sampling Area and Retrospective Power Analysis by EDA Sampling Area and Neighborhood Using Fitted Distributions

Soil Assessment--Indicator Chemicals

Appendix G

EMPIRICAL AND FITTED DISTRIBUTION OF LCICs BY EDA SAMPLING AREA AND RETROSPECTIVE POWER ANALYSIS BY EDA SAMPLING AREA AND NEIGHBORHOOD USING FITTED DISTRIBUTIONS

Following the request of Dr. Stoline in the written preliminary comments, this appendix presents tables of the percentiles of the empirical and lognormal mixture best-fit distributions for each LCIC in each sampling area.
Table G-1 (a through h) gives the actual percentile of the empirical concentrations from the soil LCIC assessment, i.e., the 90th percentile value is that concentration value from the data set which is larger than 90 percent of the other observed values. (Only Good data are presented in the tables in this appendix.)

Table G-2 (a through h) gives the estimated percentile values of the lognormal mixture fit, assuming that the fitted distribution is the correct distribution. The 90th percentile in this table is the theoretical value which is exactly greater than 90 percent of the potential observations from this distribution.

The fitted lognormal mixture distribution table has several entries for which the maximum likelihood estimation procedure failed to converge. This occurred when the lognormal mixture model was a sufficiently inadequate model for a particular LCIC and sampling area that the percentile could not be estimated.

Table G-2 also shows the estimated lognormal mixture parameters when these are estimatable. These parameters (all in log units) are the two mean values (uy1, uy2), the common standard deviation (sy), and the mixing fraction (p). Note that these parameters are all interdependent so that the fitted values for one area cannot be compared singly to those from another area, i.e., uy1 of Sampling Area 3 cannot be compared with uy1 of CT225.

Figure G-1 shows the cumulative frequency distribution for both the empirical ('+' symbols) and the fitted (solid line) lognormal mixture distributions for each LCIC and each area.

The parameters of the fitted lognormal mixture distributions are used to calculate the retrospective power of the LCIC soil assessment. Tables G-3 (univariate) and G-4 (multivariate) show estimates of the retrospective power for the sampling area comparisons with a sample size of 75. These tables correspond to Tables B-5 and B-6 of Appendix B of Volume III of the Habitability Study. Whereas the Volume III tables used a fitted lognormal distribution, Tables G-3 and G-4 use the fitted lognormal mixture distribution.

Although the estimates for retrospective power change, the general result is unchanged: the goal of achieving 90 percent power with 95 percent confidence for an order-of-magnitude difference (delta = 10) is met.

Tables G-5 (univariate) and G-6 (multivariate) show the estimates of retrospective power for neighborhood comparisons with a sample size of 35. The estimated power for comparisons at the neighborhood level (with sample sizes around 35) also meets the goal, except for beta-BHC, which has an estimated power of 85 percent with sample size 35. Note that these simulations assume that the sample size in the comparison area is the same as the EDA. Since the comparison areas had more than 35 samples, these estimates of power are likely to be biased low.

WDR359/033

Table G-1a
CONCENTRATION EMPIRICAL PERCENTILES
1,2-DICHLOROBENZENE

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25th	50th	75th	90th	95th	99th
Buff	0.24	0.36	0.58	0.93	1.01	1.38
CT221	0.32	0.39	0.53	0.81	1.06	1.15
CT225	0.29	0.43	0.65	0.84	0.99	1.40
EDA1	0.76	1.01	1.51	2.68	4.22	5.65
EDA2	0.28	0.39	0.63	1.03	2.67	19.80
EDA3	0.30	0.40	0.63	0.90	1.24	2.37
EDA4	0.28	0.36	0.50	0.66	0.91	2.23
EDA5	0.30	0.39	0.58	0.93	1.20	3.19
EDA6	0.26	0.36	0.56	0.82	1.02	1.51
EDA7	0.32	0.41	0.57	0.77	0.86	0.94

Table G-1b
CONCENTRATION EMPIRICAL PERCENTILES
1,2,4-TRICHLOROBENZENE

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25th	50th	75th	90th	95th	99th
Buff	0.11	0.14	0.19	0.28	0.31	0.92
CT221	0.46	0.65	0.98	1.13	1.85	3.12
CT225	0.33	0.61	1.18	2.84	3.90	33.07
EDA1	5.63	8.67	13.76	24.74	41.24	45.11
EDA2	0.51	0.91	1.79	4.97	8.93	167.33
EDA3	0.55	0.89	1.50	3.20	4.91	7.65
EDA4	0.29	0.44	0.96	1.97	4.05	12.08
EDA5	0.31	0.50	1.13	3.01	4.07	35.65
EDA6	0.27	0.37	0.55	0.88	1.15	3.51
EDA7	0.36	0.59	0.95	1.46	2.97	4.49

Table G-1c
CONCENTRATION EMPIRICAL PERCENTILES
1,2,3,4-TETRACHLOROBENZENE

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25th	50th	75th	90th	95th	99th
Buff	0.03	0.05	0.07	0.13	0.18	0.84
CT221	0.40	0.53	0.76	0.97	1.16	1.33
CT225	0.25	0.61	1.23	2.81	12.51	64.25
EDA1	8.06	11.48	22.43	45.42	52.41	67.20
EDA2	0.67	1.17	2.27	7.94	10.84	66.66
EDA3	0.54	1.07	1.89	2.78	4.50	9.55
EDA4	0.25	0.39	0.98	2.35	8.46	182.41
EDA5	0.22	0.43	1.05	2.61	6.61	168.64
EDA6	0.20	0.31	0.53	0.90	1.14	2.90
EDA7	0.30	0.54	1.01	1.61	2.64	3.91

Table G-1d
CONCENTRATION EMPIRICAL PERCENTILES
2-CHLORONAPHTHALENE

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25th	50th	75th	90th	95th	99th
Buff	ND	0.03	0.08	0.10	0.13	0.21
CT221	ND	0.06	0.10	0.13	0.16	0.22
CT225	ND	0.07	0.10	0.12	0.14	0.32
EDA1	ND	ND	0.09	0.16	0.18	0.21
EDA2	ND	0.04	0.07	0.10	0.14	0.24
EDA3	ND	0.04	0.09	0.10	0.12	0.15
EDA4	ND	0.04	0.88	0.11	0.12	0.13
EDA5	ND	0.06	0.88	0.11	0.12	0.16
EDA6	ND	0.06	0.10	0.12	0.15	0.19
EDA7	ND	0.06	0.10	0.13	0.15	0.18

Table G-1e
CONCENTRATION EMPIRICAL PERCENTILES
ALPHA-BHC

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25th	50th	75th	90th	95th	99th
Buff	ND	ND	ND	ND	0.01	0.17
CT221	0.06	0.18	0.29	0.42	0.66	1.19
CT225	ND	0.11	0.59	2.16	3.13	33.97
EDA1	4.98	8.25	18.06	26.07	35.09	69.70
EDA2	0.19	0.40	0.85	2.14	5.65	100.31
EDA3	0.04	0.22	0.58	1.27	3.98	16.05
EDA4	ND	0.13	0.76	3.87	16.00	152.53
EDA5	ND	0.13	0.35	1.47	5.28	83.51
EDA6	ND	0.07	0.22	0.45	0.53	1.99
EDA7	0.05	0.14	0.26	0.51	0.95	2.42

Table G-1f
CONCENTRATION EMPIRICAL PERCENTILES
DELTA-BHC

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25th	50th	75th	90th	95th	99th
Buff	ND	ND	ND	ND	ND	0.00
CT221	ND	ND	ND	ND	0.16	0.94
CT225	ND	ND	ND	0.27	0.49	5.40
EDA1	ND	1.13	1.93	3.74	9.83	38.83
EDA2	ND	0.04	0.25	0.59	1.07	2.33
EDA3	ND	ND	0.12	0.42	0.75	79.99
EDA4	ND	ND	ND	0.29	0.95	3.04
EDA5	ND	ND	ND	0.16	0.66	9.96
EDA6	ND	ND	ND	0.06	0.23	3.44
EDA7	ND	ND	ND	0.13	0.30	1.25

Table G-1g
CONCENTRATION EMPIRICAL PERCENTILES
BETA-BHC

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile 25th	50th	75th	90th	95th	99th
Buff	ND	ND	ND	ND	ND	5.36
CT221	ND	ND	0.10	0.44	0.80	1.03
CT225	ND	ND	0.46	1.41	15.61	50.57
EDA1	4.64	11.58	26.63	47.88	72.16	101.72
EDA2	ND	0.20	0.66	1.80	3.98	29.97
EDA3	ND	0.13	0.64	2.02	15.69	51.17
EDA4	ND	ND	0.47	18.26	538.82	4,108.31
EDA5	ND	ND	0.17	1.21	13.84	663.49
EDA6	ND	ND	ND	0.31	0.59	3.15
EDA7	ND	ND	0.31	0.80	1.37	2.01

Table G-1h
CONCENTRATION EMPIRICAL PERCENTILES
GAMMA-BHC

SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile 25th	50th	75th	90th	95th	99th
Buff	ND	ND	ND	ND	ND	0.04
CT221	ND	ND	ND	0.26	0.49	80.81
CT225	ND	ND	0.10	0.52	1.76	15.83
EDA1	0.79	1.73	3.23	9.17	12.16	20.99
EDA2	ND	0.09	0.24	1.03	1.83	6.67
EDA3	ND	ND	0.20	0.46	1.92	12.68
EDA4	ND	ND	0.12	0.81	16.33	85.60
EDA5	ND	ND	0.04	0.33	4.43	26.33
EDA6	ND	ND	ND	0.14	0.37	0.89
EDA7	ND	ND	ND	0.13	0.35	0.61

Table G-2a
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
1,2-DICHLOROBENZENE
SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25	50	75	90	95	99
Buff	.24	.35	.58	.87	1.07	1.52
CT221	.30	.39	.52	.78	.96	1.29
CT225	.30	.42	.63	.83	.95	1.22
EDA1	.71	1.10	1.72	2.57	3.27	5.14
EDA2	.26	.40	.64	1.03	1.78	10.80
EDA3	.30	.41	.58	.90	1.20	1.89
EDA4	.25	.36	.51	.69	.83	1.16
EDA5	.29	.40	.58	.94	1.28	1.99
EDA6	.26	.35	.56	.81	.95	1.23
EDA7	.31	.40	.57	.75	.86	1.08

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	-1.304	-.365	.413	.661
CT221	-1.034	-.222	.306	.824
CT225	-1.159	-.415	.303	.559
EDA1	.120	.094	.661	.155
EDA2	-.942	1.908	.621	.956
EDA3	-.973	.034	.428	.872
EDA4	-.977	-5.891	.487	.950
EDA5	-1.006	.075	.421	.858
EDA6	-1.227	-.356	.302	.689
EDA7	-1.075	-.428	.270	.670

Table G-2b
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
1,2,4-TRICHLOROBENZENE
SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25	50	75	90	95	99
Buff	.10	.14	.20	.27	.33	.47
CT221	.49	.65	.86	1.16	1.52	3.75
CT225	.34	.63	1.18	2.25	3.97	42.54
EDA1	4.96	8.97	15.08	23.65	30.85	50.56
EDA2	.55	1.01	1.90	3.57	5.93	119.02
EDA3	.49	.85	1.52	2.82	4.28	9.04
EDA4	.28	.49	.90	1.91	4.06	12.57
EDA5	.32	.58	1.14	2.64	5.45	15.68
EDA6	.25	.39	.60	.90	1.15	1.80
EDA7	.37	.57	.91	1.54	2.35	4.98

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	-2.041	-1.642	.485	.803
CT221	-.456	1.056	.393	.961
CT225	-.507	3.262	.884	.966
EDA1	-.352	2.296	.710	.103
EDA2	-.023	4.418	.891	.971
EDA3	-.283	1.178	.734	.882
EDA4	-.802	1.635	.791	.923
EDA5	-.648	1.699	.827	.905
EDA6	-.952	-.952	.661	.601
EDA7	-.621	.907	.600	.919

Table G-2c
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
1,2,4,5-TETRACHLOROBENZENE
SOIL ASSESSMENT--INDICATOR CHEMICALS

	Percentile					
Sampling Area	25	50	75	90	95	99
Buff	.04	.05	.08	.11	.15	.64
CT221	.39	.54	.73	.94	1.07	1.38
CT225	.28	.57	1.20	2.95	8.84	44.23
EDA1	6.29	11.97	22.35	39.01	54.37	102.78
EDA2	.66	1.20	2.35	6.13	14.09	39.15
EDA3	.53	.99	1.84	3.21	4.49	8.39
EDA4	.22	.44	.93	2.14	7.25	57.61
EDA5	.25	.49	1.01	2.18	4.97	90.24
EDA6	.19	.32	.52	.82	1.06	1.75
EDA7	.31	.53	.94	1.57	2.10	3.54

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	-2.967	-.585	.562	.975
CT221	-.394	-.999	.335	.605
CT225	-.656	2.765	.982	.933
EDA1	2.515	-2.128	.908	.972
EDA2	.062	2.605	.816	.898
EDA3	.031	-.056	.919	.524
EDA4	-.884	3.156	.992	.945
EDA5	-.767	3.778	.996	.958
EDA6	-1.121	-6.087	.724	.970
EDA7	-.931	.030	.646	.655

Table G-2d
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
2-CHLORONAPHTHALENE
SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25	50	75	90	95	99
Buff	.03	.05	.07	.10	.13	.20
CT221	.04	.06	.10	.13	.15	.19
CT225	.04	.07	.10	.13	.16	.21
EDA1	*	a	a	a	a	a
EDA2	.03	.05	.07	.11	.13	.20
EDA3	.04	.05	.09	.10	.12	.13
EDA4	.04	.05	.08	.10	.11	.13
EDA5	.04	.06	.09	.11	.12	.16
EDA6	.04	.06	.10	.13	.14	.17
EDA7	.04	.06	.10	.13	.14	.17

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	-3.005	-3.657	.621	.850
CT221	-2.249	-3.132	.277	.451
CT225	-2.513	-4.193	.433	.787
EDA1	-2.312	-6.293	.449	.475
EDA2	-2.930	-3.433	.600	.769
EDA3	-2.335	-3.157	.174	.333
EDA4	-3.160	-2.353	.185	.679
EDA5	-2.450	-3.320	.282	.521
EDA6	-2.288	-3.280	.253	.490
EDA7	-3.142	-2.217	.231	.584

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[a] Percentile estimation algorithm failed to converge.

Table G-2e
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
ALPHA-BHC
SOIL ASSESSMENT--INDICATOR CHEMICALS

	Percentile					
Sampling Area	25	50	75	90	95	99
Buff	.10	.12	.15	.19	.21	.26
CT221	.06	.17	.30	.46	.58	.91
CT225	.01	.10	.47	1.75	3.78	15.53
EDA1	5.16	9.67	17.02	27.76	37.08	63.67
EDA2	.14	.36	.98	2.52	4.70	40.98
EDA3	.03	.23	.65	1.47	2.36	5.62
EDA4	.03	.12	.57	3.42	15.51	182.52
EDA5	.02	.09	.37	1.66	5.11	70.00
EDA6	.02	.08	.23	.42	.59	1.06
EDA7	.05	.14	.29	.53	.75	1.40

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	-2.090	-2.090	.318	.806
CT221	-1.432	-3.229	.611	.690
CT225	-6.469	-1.757	2.000	.191
EDA1	2.386	.554	.771	.890
EDA2	-1.043	4.347	1.447	.985
EDA3	-.959	-7.000	1.202	.758
EDA4	2.883	-2.311	1.926	.087
EDA5	-2.571	2.577	2.000	.952
EDA6	-1.521	-3.751	.759	.515
EDA7	-1.672	-4.563	.894	.812

Table G-2f
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
DELTA-BHC
SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile					
	25	50	75	90	95	99
Buff	a	a	a	a	a	a
CT221	.01	.01	.02	.03	.06	.81
CT225	.00	.00	.01	.20	.55	2.19
EDA1	.97	1.83	3.49	6.15	8.54	15.48
EDA2	.00	.05	.26	.59	.90	1.90
EDA3	.00	.00	.08	.56	1.20	4.33
EDA4	.00	.00	.01	.27	.64	2.35
EDA5	.00	.01	.04	.14	.42	6.76
EDA6	.00	.00	.00	.04	.23	1.29
EDA7	.00	.01	.01	.13	.33	.97

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	a	a	a	a
CT221	-4.666	-.736	.809	.959
CT225	-7.000	-1.322	1.343	.830
EDA1	.171	1.201	.765	.568
EDA2	-1.392	-5.522	.981	.524
EDA3	-7.000	-1.271	1.460	.687
EDA4	-7.000	-1.540	1.400	.770
EDA5	.644	-4.532	1.668	.045
EDA6	-7.000	-1.764	1.476	.883
EDA7	-5.389	-1.493	1.008	.859

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[a] No feasible lognormal mixture fit.

Table G-2g
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
BETA-BHC
SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile 25	50	75	90	95	99
Buff	a	a	a	a	a	a
CT221	.00	.00	.10	a	a	a
CT225	.00	.02	.47	2.33	5.39	23.99
EDA1	5.35	12.57	28.65	47.74	62.61	99.97
EDA2	.00	.22	.84	2.18	3.74	10.09
EDA3	.00	.08	.83	2.91	5.77	19.09
EDA4	.01	.06	.30	5.03	137.77	1868.44
EDA5	.00	.00	.18	2.06	5.78	32.62
EDA6	.00	.00	.00	.33	a	a
EDA7	.01	.03	.32	.75	1.14	2.34

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	-1.021	1.679	.001	.509
CT221	-7.000	-1.370	.956	.701
CT225	-.742	-7.000	1.894	.497
EDA1	3.336	1.668	.619	.509
EDA2	-.602	-7.000	1.332	.667
EDA3	-7.000	-.374	1.586	.450
EDA4	-3.125	5.000	2.000	.903
EDA5	-7.000	-.289	2.000	.674
EDA6	-7.000	-1.215	.941	.778
EDA7	-.929	-4.472	.897	.421

---

[a] Percentile estimation algorithm failed to converge.

Table G-2h
CONCENTRATION LOGNORMAL MIXTURE PERCENTILES
GAMMA-BHC
SOIL ASSESSMENT--INDICATOR CHEMICALS

Sampling Area	Percentile 25	50	75	90	95	99
Buff	a	a	a	a	a	a
CT221	.00	.01	.03	.10	.27	63.52
CT225	.00	.00	.05	.64	1.51	5.87
EDA1	1.25	2.29	4.20	7.26	10.08	18.64
EDA2	.00	.07	.27	.80	1.47	4.48
EDA3	.00	.00	.20	.73	1.36	4.06
EDA4	.00	.02	.09	.80	6.96	97.65
EDA5	.00	.01	.05	.45	3.25	27.82
EDA6	.01	.02	.03	.14	.31	.75
EDA7	.01	.02	.04	.15	.26	.55

ESTIMATED PARAMETERS

Sampling Area	uy1	uy2	sy	p
Buff	a	a	a	a
CT221	-5.040	4.244	2.000	.981
CT225	-.963	-7.000	1.514	.274
EDA1	.598	1.044	.872	.484
EDA2	-1.856	-7.000	1.528	.700
EDA3	-7.000	-1.269	1.337	.579
EDA4	-4.332	2.087	2.000	.907
EDA5	-4.782	1.048	1.725	.894
EDA6	-4.315	-1.357	.770	.876
EDA7	-1.769	-4.165	.742	.175

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[a] No feasible lognormal mixture fit.

Table G-3

POWER (AT ALPHA = 0.05) FOR UNIVARIATE TESTS BASED ON LOGNORMAL MIXTURE PARAMETERS GIVEN IN TABLE G-2 FOR GOOD DATA GIVEN IN TABLE B-4 OF FINAL REPORT VOLUME III, WITH SAMPLE SIZE 75

	LCIC[b]							
Delta[a]	1	2	3	4	5	6	7	8
.00	.046	.051	.052	.046	.048	.046	.047	.043
.05	.173	.093	.076	.066	.062	.066	.059	.059
.10	.408	.187	.119	.096	.096	.096	.072	.072
.20	.847	.459	.253	.200	.136	.200	.100	.105
.50	1.000	.961	.678	.525	.338	.525	.198	.259
1.00	1.000	1.000	.972	.878	.676	.878	.360	.520
2.00	1.000	1.000	1.000	.996	.958	.996	.678	.827
5.00	1.000	1.000	1.000	1.000	1.000	1.000	.943	.991
10.00	1.000	1.000	1.000	1.000	1.000	1.000	.996	1.000

---

[a] LCIC concentrations in EDA sampling area are drawn from a statistical population related to that of the comparison area by the factor 1+delta; delta=10.0 corresponds to an order of magnitude shift.

[b] LCIC 1 = 1,2-Dichlorobenzene
2 = 1,2,4-Trichlorobenzene
3 = 1,2,3,4-Tetrachlorobenzene
4 = Chloronaphthalene
5 = alpha BHC
6 = delta BHC
7 = beta BHC
8 = gamma BHC

Table G-4
POWER FOR MULTIVARIATE TESTS FOR PARAMETERS GIVEN IN TABLE G-2 FOR INTERVARIABLE CORRELATION GIVEN IN TABLE B-7 OF FINAL REPORT VOLUME III, FOR SAMPLE SIZE 75

	ALPHA				
Delta[a]	.0100	.0250	.0500	.1000	.2000
.00	.007	.026	.059	.095	.203
.05	.009	.022	.058	.113	.217
.10	.008	.030	.062	.128	.238
.20	.025	.057	.108	.175	.328
.50	.182	.292	.407	.539	.705
1.00	.686	.797	.873	.931	.965
2.00	.979	.988	.995	.998	.999
5.00	.999	.999	1.000	1.000	1.000
10.00	1.000	1.000	1.000	1.000	1.000

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[a] LCIC concentrations in EDA sampling area are drawn from a statistical population related to that of the comparison area by the factor 1+delta; delta=10.0 corresponds to an order of magnitude shift.

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Table G-5
POWER (AT ALPHA = 0.05) FOR UNIVARIATE TESTS BASED ON LOGNORMAL MIXTURE PARAMETERS GIVEN IN TABLE G-2 FOR GOOD DATA GIVEN IN TABLE B-4 OF FINAL REPORT VOLUME III, WITH SAMPLE SIZE 35[a]

	LCIC[b]							
Delta[a]	1	2	3	4	5	6	7	8
.00	.046	.060	.046	.060	.048	.046	.062	.046
.05	.118	.106	.082	.148	.058	.072	.068	.062
.10	.258	.162	.116	.250	.075	.100	.078	.072
.20	.580	.280	.178	.602	.111	.160	.092	.098
.50	.986	.728	.424	.992	.231	.328	.146	.164
1.00	1.000	.990	.784	1.000	.462	.614	.254	.318
2.00	1.000	1.000	.986	1.000	.780	.914	.416	.562
5.00	1.000	1.000	1.000	1.000	.978	.996	.734	.888
10.00	1.000	1.000	1.000	1.000	1.000	1.000	.882	.968

---

[a] LCIC concentrations in EDA sampling area are drawn from a statistical population related to that of the comparison area by the factor 1+delta; delta=10.0 corresponds to an order of magnitude shift.

[b] LCIC 1 = 1,2-Dichlorobenzene
2 = 1,2,4-Trichlorobenzene
3 = 1,2,3,4-Tetrachlorobenzene
4 = Chloronaphthalene
5 = alpha BHC
6 = delta BHC
7 = beta BHC
8 = gamma BHC

Table G-6
POWER FOR MULTIVARIATE TESTS FOR PARAMETERS GIVEN IN TABLE G-2 FOR INTERVARIABLE CORRELATION GIVEN IN TABLE B-7 OF FINAL REPORT VOLUME III, FOR SAMPLE SIZE 35

	ALPHA				
Delta[a]	.0100	.0250	.0500	.1000	.2000
.00	.006	.012	.038	.084	.202
.05	.006	.014	.042	.096	.212
.10	.006	.014	.048	.102	.222
.20	.010	.030	.056	.118	.242
.50	.032	.084	.164	.288	.454
1.00	.172	.320	.468	.604	.758
2.00	.556	.664	.752	.860	.936
5.00	.812	.924	.956	.978	.994
10.00	.914	.970	.982	.990	.994

---

[a] LCIC concentrations in EDA sampling area are drawn from a statistical population related to that of the comparison area by the factor 1+delta; delta=10.0 corresponds to an order of magnitude shift.

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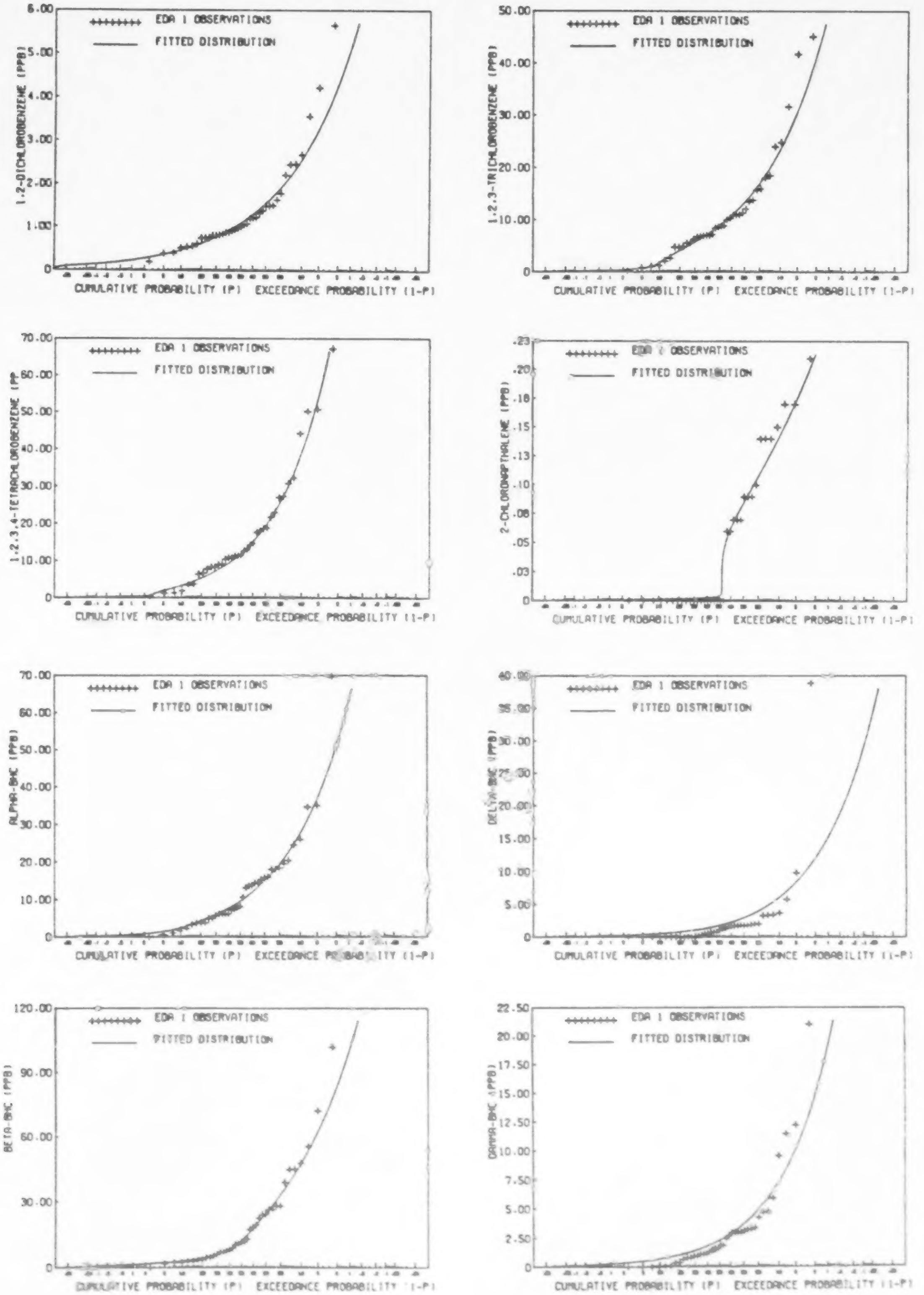

Figure G-1a SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN EDA SAMPLING AREA 1

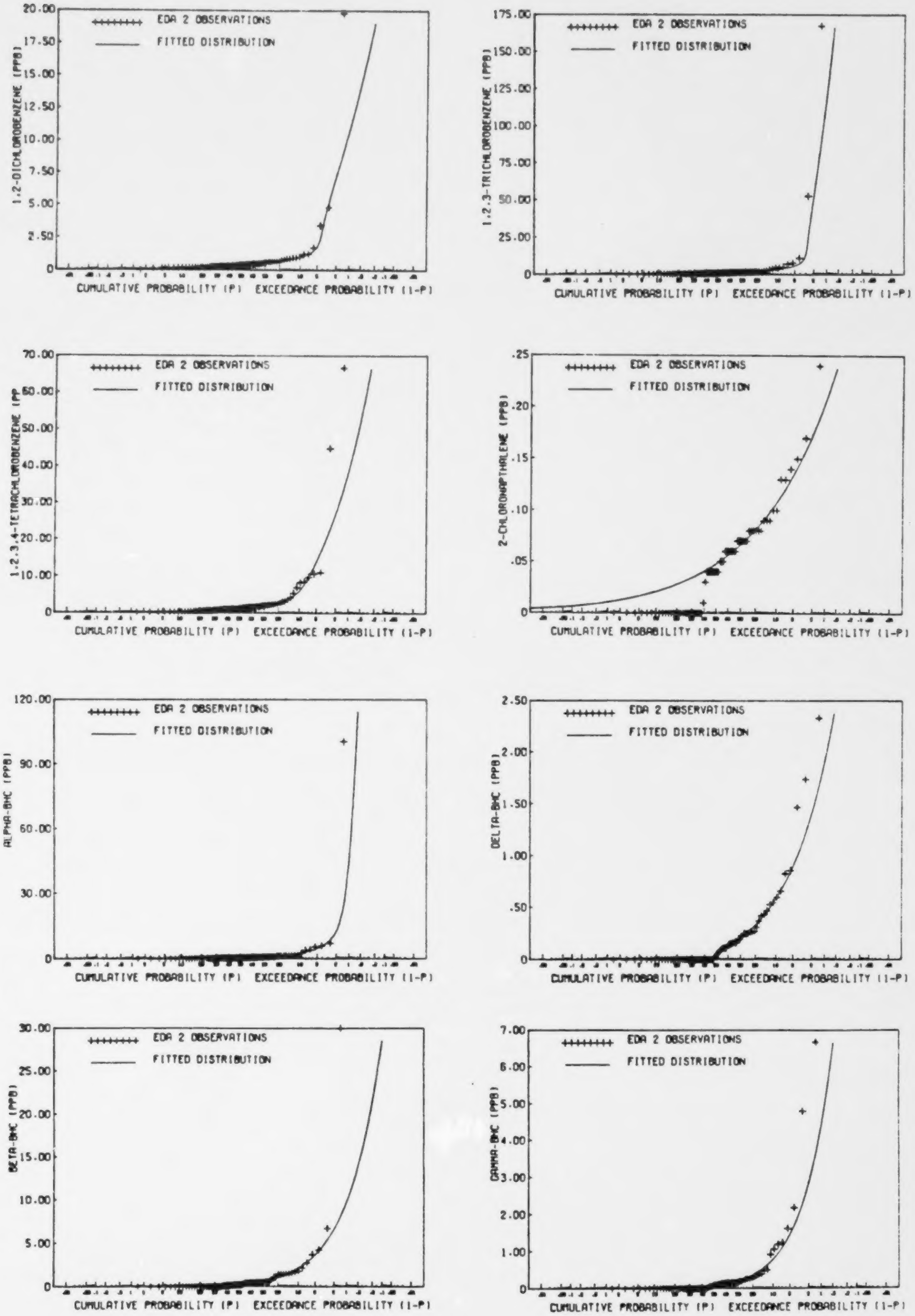

Figure G-1b SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN EDA SAMPLING AREA 2

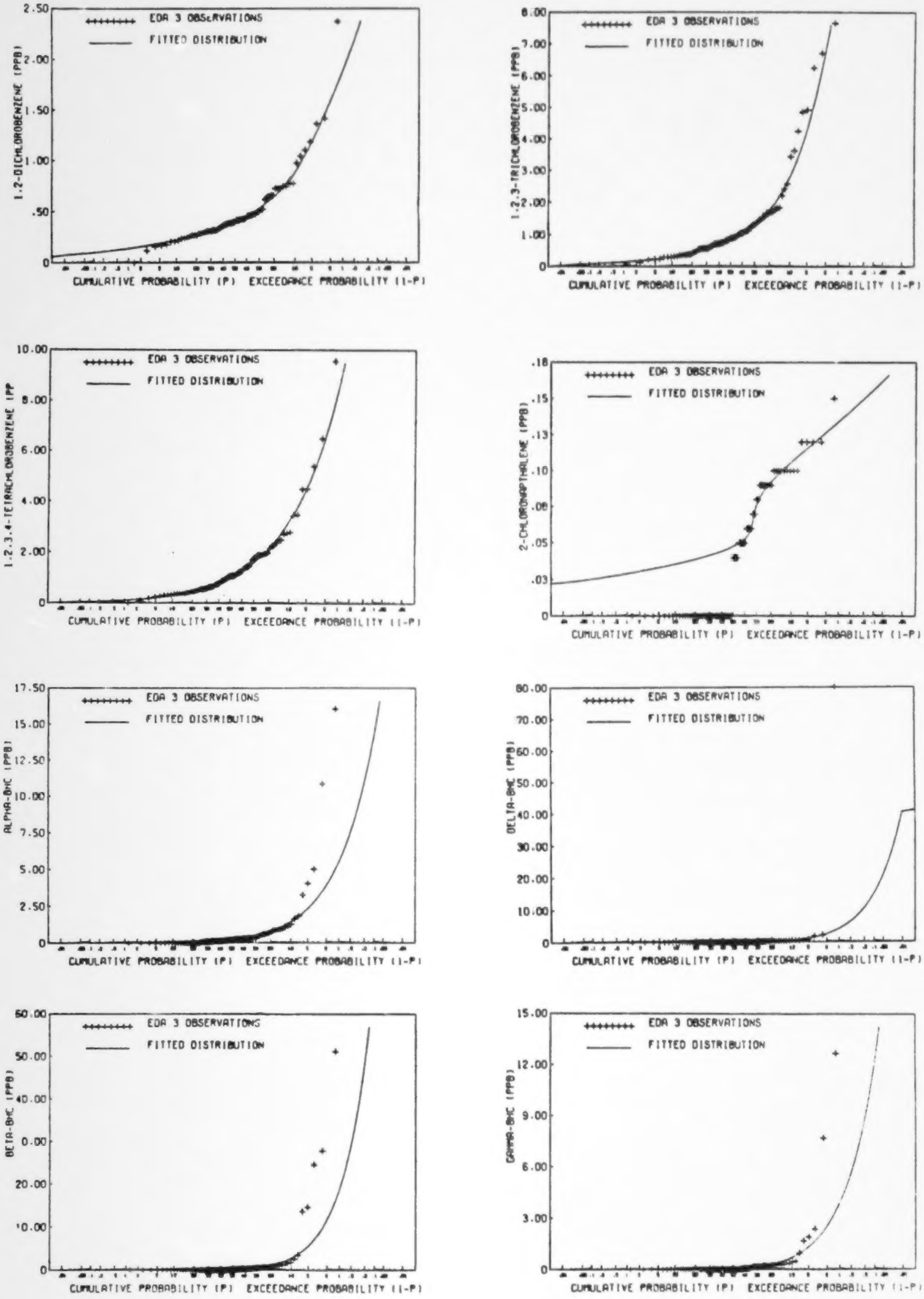

Figure G-1c SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN EDA SAMPLING AREA 3

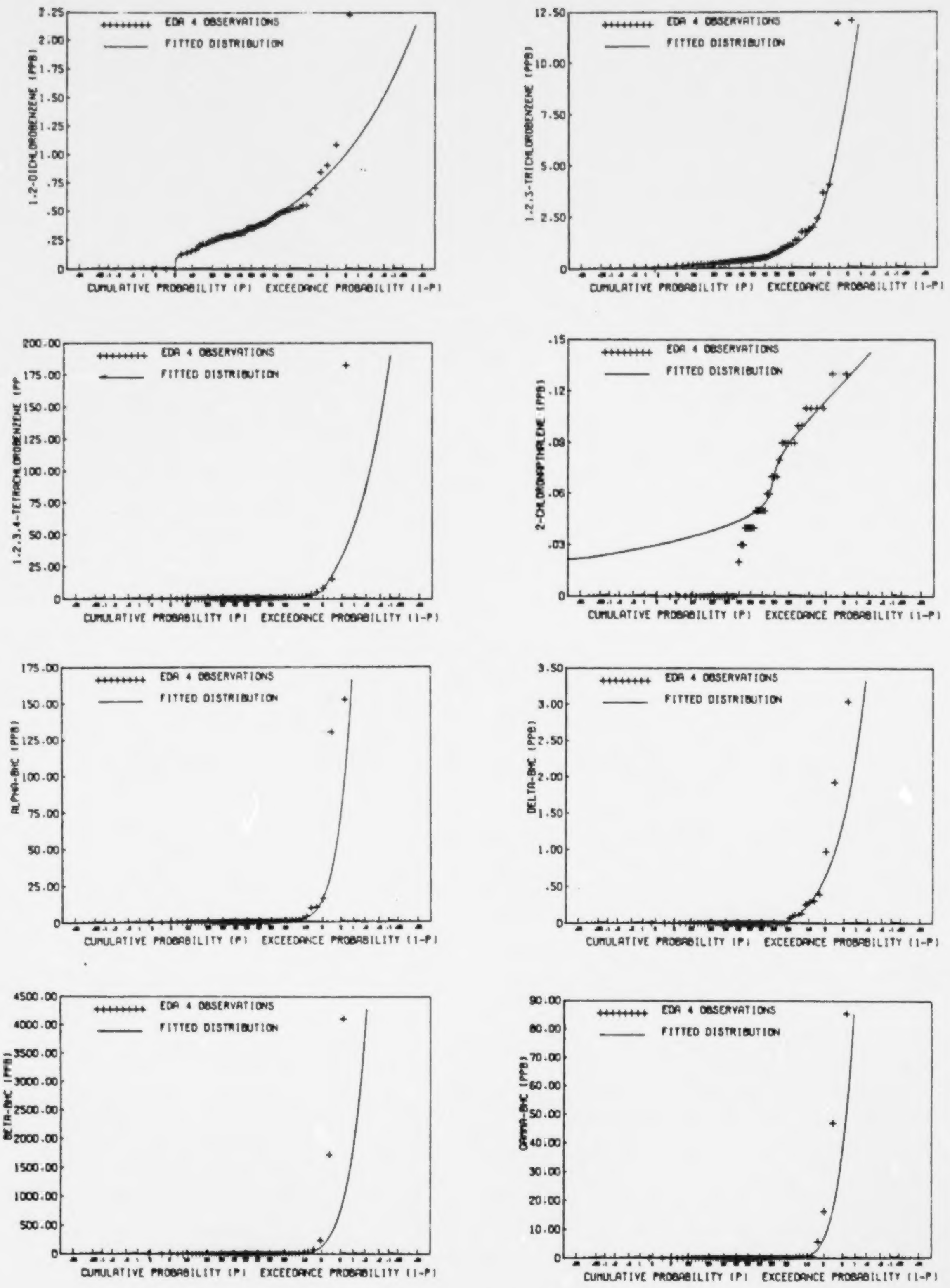

Figure G-1d SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN EDA SAMPLING AREA 4

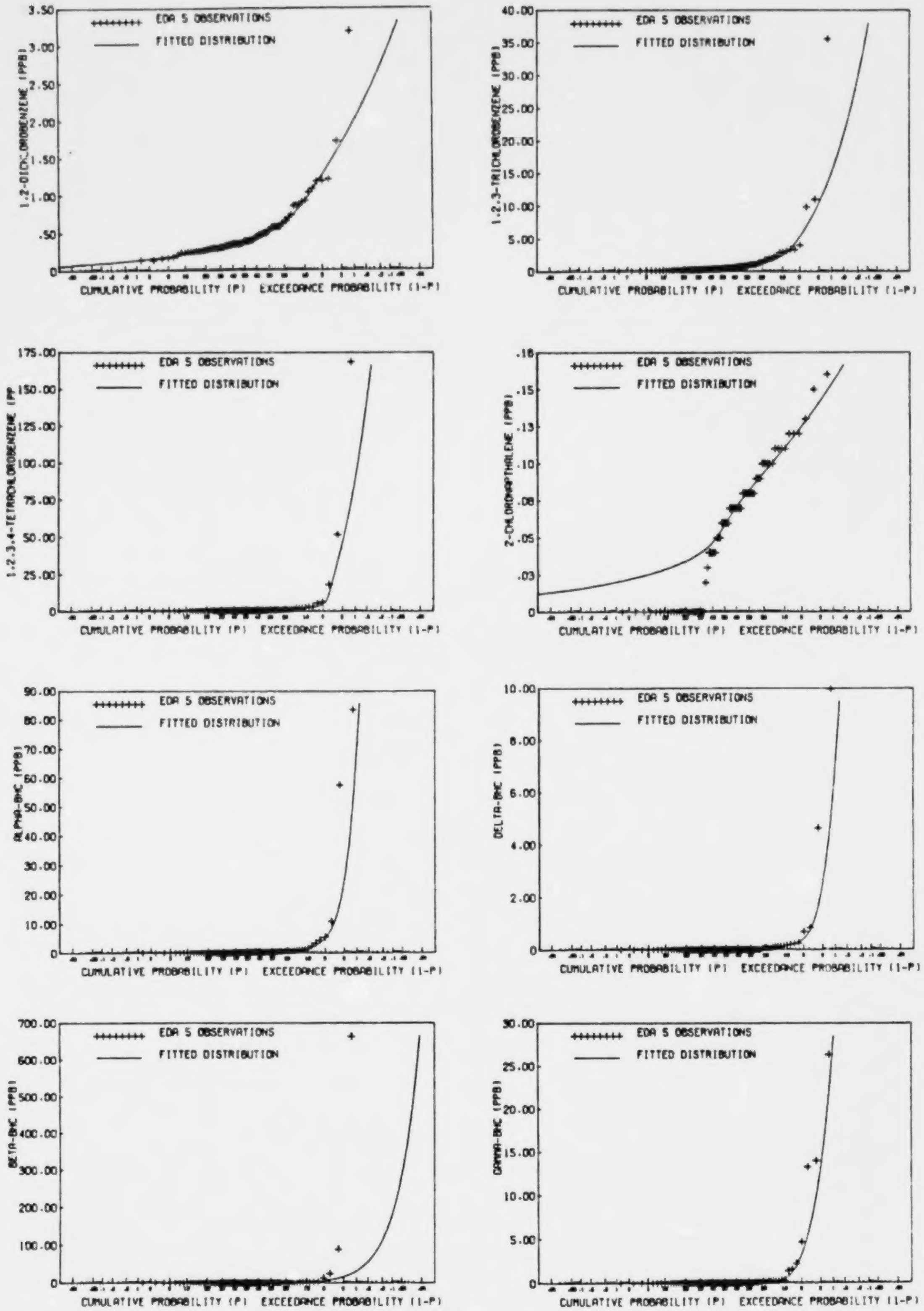

Figure G-1e SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN EDA SAMPLING AREA 5

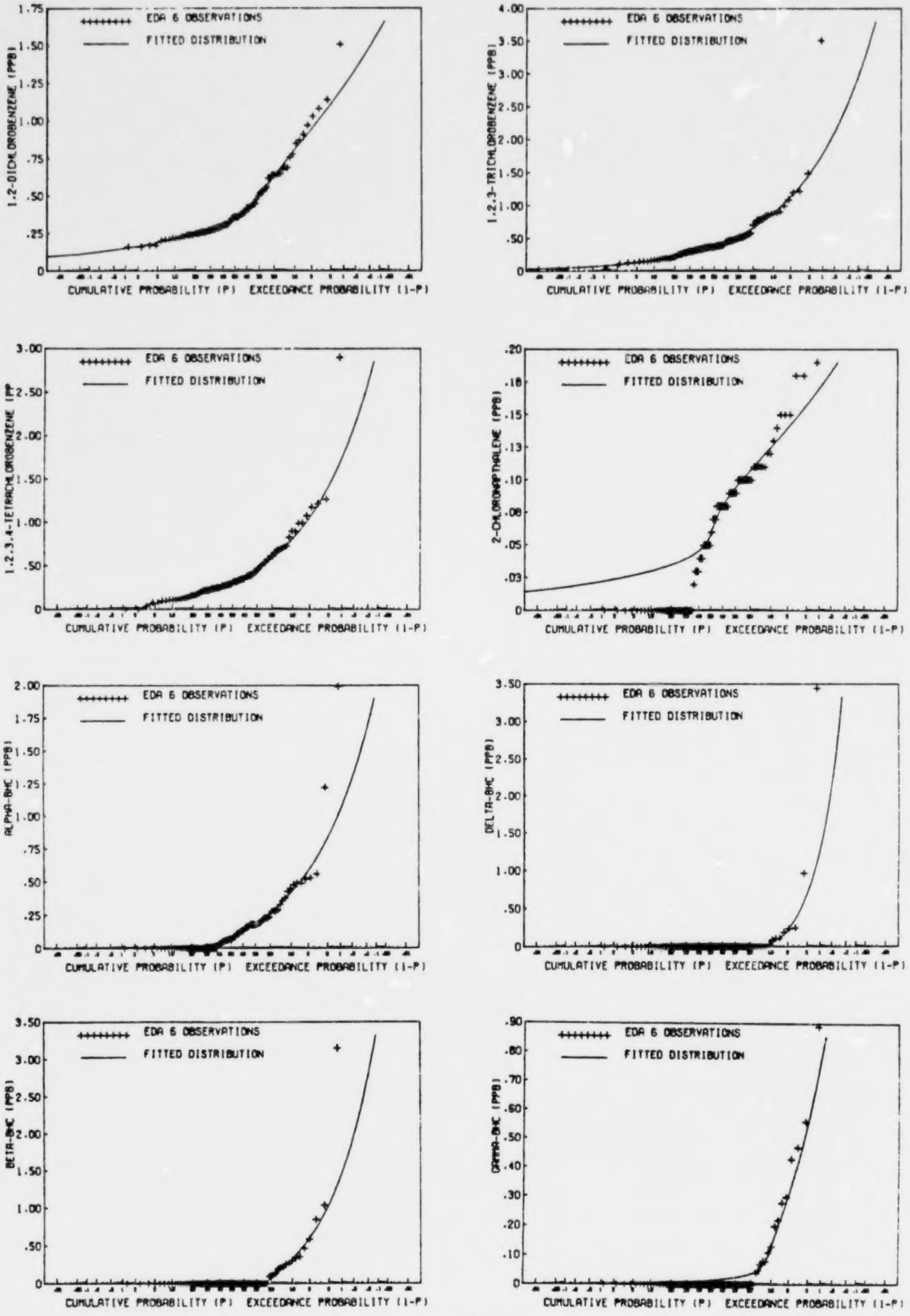

Figure G-1f SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN EDA SAMPLING AREA 6

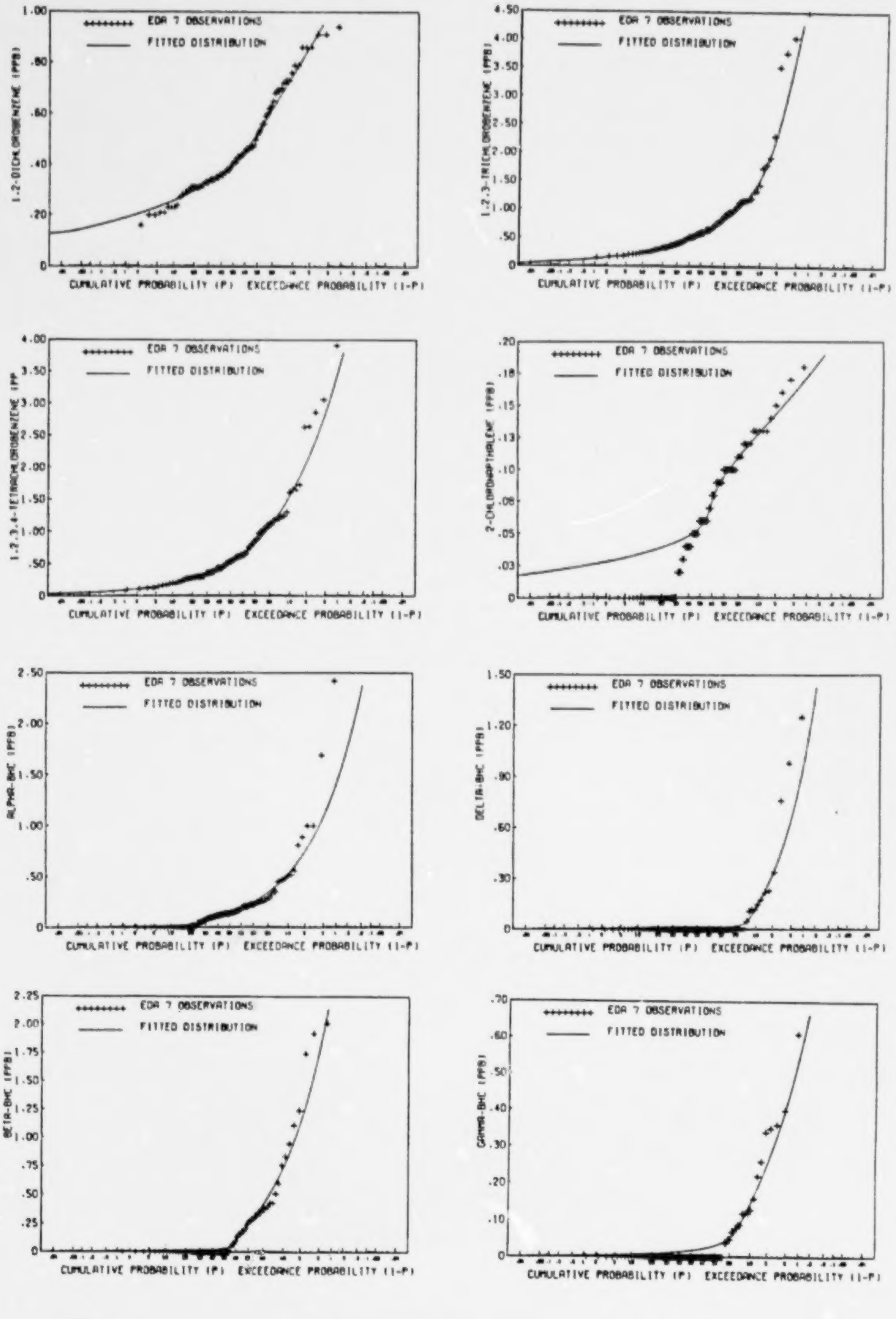

Figure G-1g SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN EDA SAMPLING AREA 7

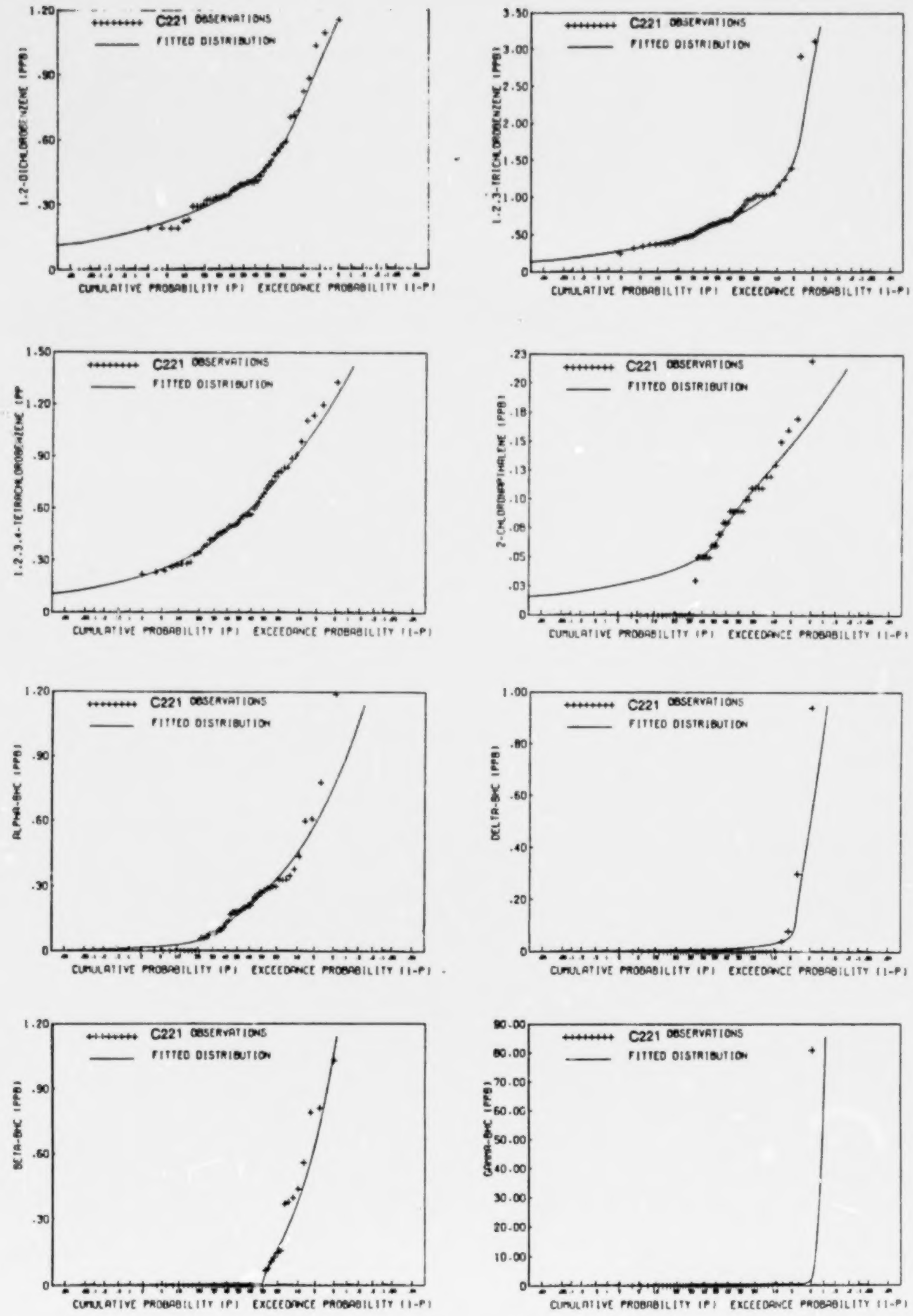

Figure G-1h SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN THE CENSUS
TRACT 221 COMPARISON AREA

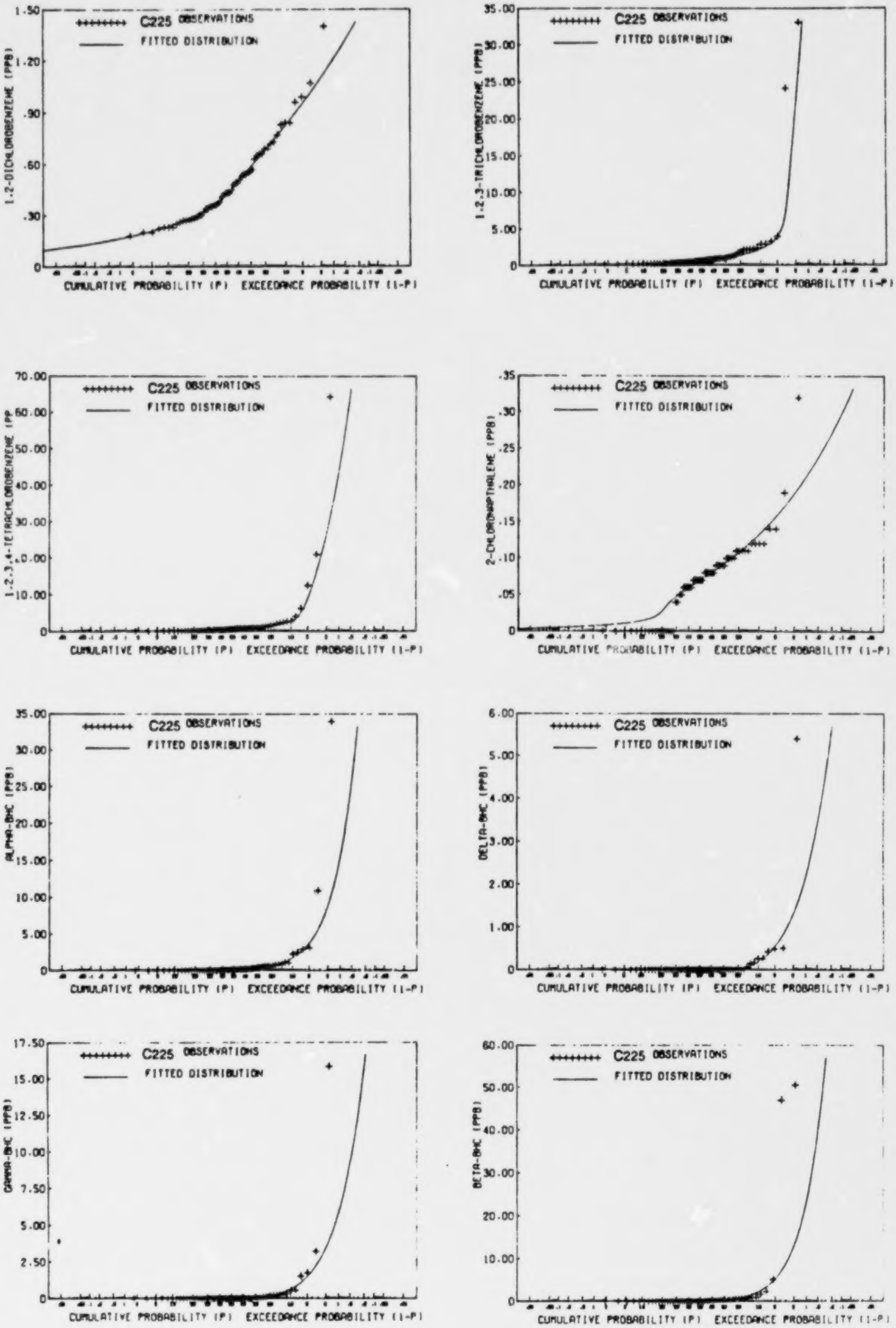

Figure G-1l SOIL ASSESSMENT -- INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN THE CENSUS TRACT 225 COMPARISON AREA

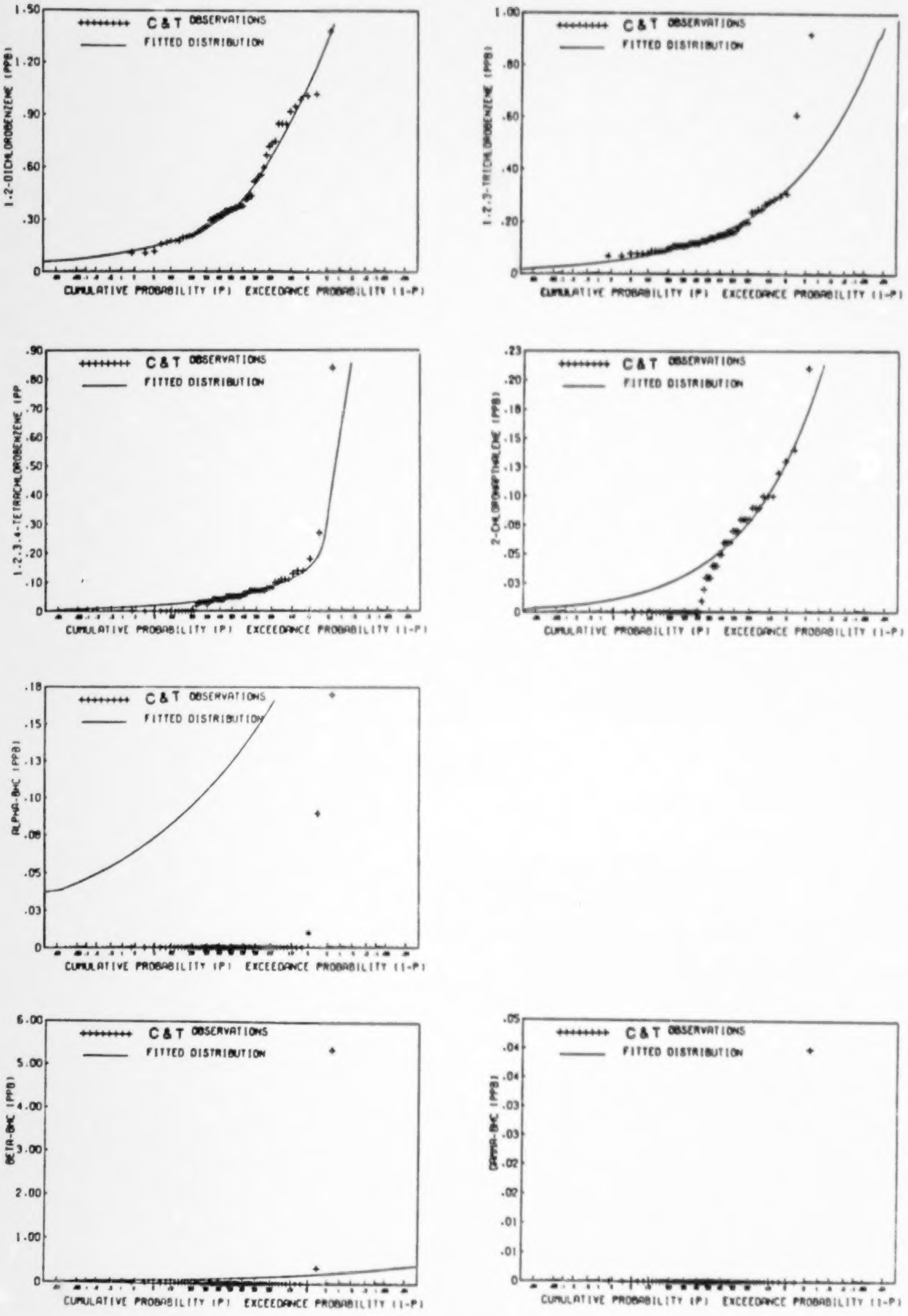

Figure G-1j SOIL ASSESSMENT – INDICATOR CHEMICALS
CUMULATIVE FREQUENCY DISTRIBUTIONS FOR LCICs IN THE
CHEEKTOWAGA AND TONAWANDA COMPARISON AREA

APPENDIX H
Detection Limits

Soil Assessment--Indicator Chemicals

Appendix H
DETECTION LIMITS
SOIL ASSESSMENT--INDICATOR CHEMICALS

Dr. Stoline, in his preliminary written comments inquired as to whether or not the detection limits had been improved from the pilot study. An estimate of the operational detection limit was provided in Volume III of this series. This appendix discusses the variety of definitions of detection limits in the current literature and provides other estimators of the detection limit. The following sections provide background information, discuss physical characteristics of the laboratory analysis, and present a model for estimating the method.

BACKGROUND

The 1980 Love Canal study found that more than 95 percent of the samples analyzed had concentration levels that were too low to quantify. This was an unexpected result of the study, and no systematic effort had been made during the laboratory analysis to determine the level of detection for the analytical methods. A retrospective analysis indicated that the level of detection was no greater than 1.0 ppm. A review by Congressional Office of Technology Assessment (OTA) of the study concluded that the number of samples with non-detect concentrations made the statistical comparison difficult. The OTA reported that, based on the available information, it was not possible to conclude whether or not unsafe levels of contamination existed in the EDA (OTA, 1983).

The current Love Canal indicator chemical soil assessment responded to these concerns on three levels. First, the analytical techniques were improved to allow detection of concentrations that are two to three orders of magnitude smaller than those believed to have been detected in the 1980 study. Second, statistical techniques were used to perform the sampling area to comparison area comparisons, which were robust to the presence of nonquantifiable values. Third, specific analyses were conducted to enable an estimate of the detection limit. These analytical methods and statistical techniques are discussed in the sample analysis QAPP (CH2M HILL, 1987) and Volume II, respectively. This appendix will discuss the methods used to estimate the detection limits of the analytical method.

The term "detection limit" is not as well defined as one might think. The term has been used in the literature with a number of different definitions and associated estimators (Currie, 1988). Currie lists four types of detection limits in current use: lower limit of detection, instrumental detection limit, method detection limit, and limit of detection. Each of these types has one or more estimators that can be used to quantify that particular detection limit.

The detection limit of interest for this study is the method detection limit, which is defined here as that concentration of an analyte in soil that can be differentiated from a soil matrix containing zero concentration with 95 percent confidence and 95 percent power. This corresponds to the statistical definition of the minimum detectable difference between a sample with a concentration of an analyte at the method detection limit and a sample with a zero concentration of an analyte.

Three different estimators of the method detection limit have been proposed. One method quantifies the uncertainty (variance) of instrument response when measuring blank soil samples (Currie, 1968). This variance is then assumed to be similar to the variance of the instrument response when a low level of an analyte is present. Standard statistical hypothesis testing techniques are then used to estimate the minimum detectable difference from the blank as the method detection limit.

A second technique, similar to the first, uses low-level spiked (known) concentrations, rather than blanks, to estimate the variability of the instrument response (Glaser, et al., 1981). The variance of blanks is then assumed to be similar to that of low-level spikes, and standard hypothesis testing techniques are again used to estimate the minimum detectable difference.

The third method uses the linear calibration curve to estimate the detection limit (Sharaf, et al., 1986). This method uses the instrument sensitivity to pure solutions of the target compounds as well as the uncertainty in response at several concentrations to estimate the detection limit.

An estimator for the method detection limit that is similar to that based on the calibration curve but based on estimated concentrations is the most appropriate for the Love Canal indicator chemical soil assessment. This method has three advantages:

- It includes the variance of instrument response at several concentrations; the methods of Currie and Glaser only use a single concentration.
- It includes the variance of the calibration curve that the other methods do not.

- o It is based on estimated concentrations of measurements on soil samples and, therefore, includes some of the variability resulting from chemical interference.

There are, however, limitations to this estimator that are not resolved in the current literature. An understanding of the analytical process is necessary to discuss the advantages and limitations of this estimator.

PHYSICAL CHARACTERISTICS OF THE LABORATORY ANALYSIS

The analytical method used in the Love Canal soil assessment for indicator chemicals is discussed in detail in the sample analysis QAPP (CH2M HILL, 1987). The method can be summarized briefly by discussing the theory of operation of the GC/MS, the method of calibration, and the analysis of unknown samples.

A GC/MS analysis begins by the injection of a small quantity of a solution containing the target analytes (chemicals of interest, here LCICs) into the GC part of the instrument. The solution is vaporized into a gas and fed into a long capillary column. The interaction of the molecules of the vaporized solution with the interior of the capillary tube causes different molecular species to pass through the column at different speeds. The time that each species takes to pass through the column (elute) is a characteristic that can be used to help identify the molecular species.

The time required for a molecular species to elute from the chromatographic column is not, however, a unique identifier of an analyte. Identification is accomplished by feeding the gas eluting from the GC into the MS.

In the MS, the molecular species are bombarded with an electron beam that breaks the molecules into a number of charged ions. Each ion has a mass and is usually singly charged. The ions are screened by an "electronic window" that only allows ions of a given mass-charge ratio to pass at a given time. The ions that pass this window are then counted by a detector.

Since the "electronic window" can be switched very rapidly to allow passage of ions of different masses, an estimate can be made of the numbers of ions in several mass categories for each molecular species. The count of ions must take place during the time that the particular molecular species is eluting from the GC. Therefore, the more ion masses that are counted, the less time there is for counting ions at each mass. This decreases the resolution of the instrument.

One of the goals of the soil assessment for indicator chemicals was to decrease the detection limit. One of the methods used to accomplish this was to increase the instrument resolution by decreasing the number of ion masses examined for each LCIC. This mode of operation for a GC/MS is known as Selected Ion Monitoring (SIM). The SIM method used for LCIC detection used three predefined ion masses for each LCIC. The total counts of ions at these three masses then formed the basis for positive identification and quantitation of each LCIC.

Identification of an LCIC is accomplished in the MS after three criteria are met. The candidate molecules for an LCIC must elute from the GC within an appropriate time frame. The primary and secondary (first and second most common) ion counts must be present in a ratio that is close to the theoretical ratio. Finally, all three ions must be present.

Once an LCIC has been identified by these criteria, the concentration is estimated using the quantity of primary ions present (as estimated by the extrapolated total ion count), the total count of the internal standard primary ion, the calibration information from the continuing calibration done at the beginning of the shift, and information from the initial calibration. The general procedure involves comparing the instrument response to the unknown quantity of LCIC with the instrument response to the known LCIC concentrations used during the calibration process.

The GC/MS is calibrated as part of setting the instrument for analyzing LCICs. The calibration is checked regularly, and the instrument is recalibrated whenever it fails the calibration criteria. The initial calibration consists of analyzing five solutions containing three classes of chemicals: the LCICs, the Internal Standards (IS), and the surrogate standards. The LCICs are at five different concentration levels that span the range of interest and to which the instrument response is thought to be linear. The data from these five analyses are used to set up the calibration curve.

A constant quantity of IS chemicals is added to solutions before injection into the GC and used for quantitating the LCICs in unknown solutions. The internal standards are chosen to elute near groups of LCICs and are used to compensate for small variations in injected volume as well as run-to-run variation in instrument responsiveness.

The surrogate standard chemicals are added in known quantities to each soil sample before extraction. The amount recovered in the form of estimated concentrations from the analysis is used to provide a rough measure of the efficiency of the extraction process.

The IS and surrogate standards are always analyzed at a single, specific concentration.

The relation between the LCICs and the IS is established during the initial calibration. The relation is updated with a continuing calibration analysis of the lowest LCIC calibration level at the beginning of each shift.

The analysis of unknown samples starts with the addition of the surrogate chemical solution to the soil sample. This soil then has solvents added to extract the LCICs and surrogates. After several steps in the extraction process, the extract is concentrated and stored. When the extract is to be analyzed, the ISs are added to the solution, and a portion is removed for injection into the GC/MS.

This process has several sources of variability that contribute to the uncertainty associated with concentration estimates:

- The efficiency of the extraction process in removing all the LCICs from the soil is unknown and cannot be estimated. The extraction efficiency of the surrogates is similar to, but not sufficiently highly correlated with, the extraction efficiency of LCICs to allow a recovery correction to concentration estimates.

- The extraction process also obtains other chemicals from the soil matrix. Many of these chemicals will elute from the GC at similar times as the LCICs and even have an ion in common with an LCIC in the MS. This produces interferences and chemical noise in the analysis. If the matrix chemicals that interfere are present in sufficient quantity, they may prevent identification of an LCIC by throwing off the ratio of LCIC ions or by obscuring the presence of an ion. Even low levels of matrix chemicals can contribute additional uncertainty in the quantitation of the LCICs.

- Finally, the GC/MS instrument has some inherent variability in the concentration estimates. This is estimated from the difference of the actual instrument response from that predicted by the calibration curve.

The bulk of the uncertainty associated with estimating LCIC concentration is associated with the matrix. The matrix effects are the major determinates of the detection limits. The major matrix interferences that prevent the identification of the LCICs are not included in this model. The occurrence of such interferences is uncorrelated with the concentration of LCICs. The effect of the process, whereby matrix interferences are sufficient to prevent identification, is to make the detection limit model conditional on the absence of interferences of this type or magnitude.

METHOD DETECTION LIMIT MODEL

An estimator for the method detection limit can be developed based on the calibration curve method, but using recoveries of known amounts of analytes spiked into soil rather than pure analytes in solvent (Hubaux and Vos, 1967). The method consists of a regression of the estimated concentration on the actual spiked concentration. This model has the following limitations:

- The model is conditional on the absence of interferences sufficient to prevent identification. A separate statistical model is required to estimate the probability of a field sample having nonquantifiable concentrations due to matrix interferences.

- The model assumes that the variability of the estimates is independent of the magnitude of the estimates.

- The model assumes that the estimated concentrations are a linear function of the true concentrations.

- The model assumes that a concentration can be estimated validly for an arbitrarily low spiked concentration. Any interfering compounds present will be sufficient to prevent the proper identification of sufficiently small spiked concentrations.

- The model is sensitive to the concentration levels of the spiking solutions. This is because of the uncertainty in regression relation resulting in prediction limits that become wider the further removed the detection limit estimate is from the mean spiked concentration.

The parameters of the linear regression reflect the various processes involved in the chemical analysis. The uncertainty associated with an estimate at a given concentration is due to the matrix effects and instrumental variance. The slope of the regression reflects the sensitivity of the instrument response to the LCIC concentration. The intercept of the regression reflects the presence of background concentrations of LCICs in the soil or in the laboratory solvents.

Figure H-1 illustrates the various aspects of the model and shows several concentrations estimated for spiked concentrations. A regression relation (solid line) is estimated from these points, and the 95th percentile of predicted estimated concentrations is also estimated (dashed line). A pair of line segments that form a right angle graphically illustrates the detection limit process.

The method detection limit is estimated from the regression by examining the prediction limits of the relation. These limits are the 5th and 95th percentile bounds for predicting what the estimated concentration would be for a given known concentration in the sample. The upper prediction limit for a blank corresponds to the highest concentration that would be estimated 95 percent of the time when analyzing a blank. (Note that this is not quite appropriate for a GC/MS, as blank samples would be expected to fail identification criteria.)

The true concentration whose expected estimated concentration corresponds to the 95th percentile of estimated concentrations when a sample contains no LCICs (a blank) is then the criterion level concentration. This concentration is greater than that estimated for 95 percent of all blanks.

The true concentration, whose 5th percentile bound on the predicted concentration estimate corresponds to the 95th percentile bound on predicted concentrations for blanks, is then the method detection limit. This is the concentration that will be differentiated from a blank 95 percent of the time.

This estimate is shown in Figures H-2 (a through h), H-3 (a through h), and H-4 (a through h) for LCICs during the soil assessment study. These figures show the Hubaux-Vos estimates of detection limits for six laboratories and eight LCICs for three different data sets. Each graph shows the regression line between spiked and estimated concentrations, the 5th and 95th percentile prediction bounds, and the detection limits. The detection limits are shown by tracing a line from the 95th percentile bound for blanks to the 5th percentile bound for the method detection limit. The line then drops from the 5th percentile bound down to the actual concentration axis.

Occasionally, the line illustrating the detection limit estimation process will not exactly meet the lower prediction interval curve. This is caused by a round-off error in the computer, and it does not interfere with the illustration of the range and magnitude of the Hubaux and Vos detection limits seen in the study.

Figures H-2 (a through h) show the detection limits estimated for each laboratory for each LCIC. These estimates are based on the PE data obtained when the laboratories were qualifying for participation in the study. The samples analyzed were spiked at several low levels by EMSL-LV and analyzed in duplicate by all the laboratories.

Figures H-3 (a through h) are a similar series of plots. This is the same data set with the spiked concentrations greater than 1.0 ppb removed. This series of plots indicates the sensitivity of the Hubaux and Vos estimators to the range of concentrations used. Note that the detection limits estimated with this data set are lower than those using the full data set.

Figures H-4 (a through h) are the same series of plots using data from the EMSL-LV BQC samples. These samples were analyzed during the course of the study at a rate of one BQC sample for every 20 field samples. The BQC samples covered a wider range of spikes than the PE sample spikes.

After reviewing these figures, one can note that the estimates of the method detection limit are quite variable from laboratory to laboratory, from LCIC to LCIC, and from data set to data set. What these estimates provide is an upper bound on the concentration levels likely to be present and still to be found nonquantifiable (non-detect). The estimates include the variability of matrix effects and recovery efficiencies, and thus, they represent a "worst case" of what can be detected. An estimate of a detection limit from this method does not mean that lower concentrations cannot be detected; rather, this is an indication of the concentration that probably would be detected if it were present.

WDR357/031

REFERENCES

CH2M HILL. 1987. Love Canal Habitability Study. Soil Sample Laboratory Analysis Quality Assurance Project Plan.

Currie, Lloyd. 1988. Detection in Analytical Chemistry Importance, Theory and Practice. American Chemical Society. Washington D.C. Pp 1-64

Currie, Lloyd. 1968. Limits for Qualitative Detection and Quantitative Determination. Application to Radiochemistry. Analytical Chemistry. Volume 40, No. 3. Pp 586-593.

Hubaux, Andre and Gilbert Vos. 1970. Decision and Detection Limits for Linear Calibration Curves. Analytical Chemistry. Volume 42, No. 8. Pp 849-855.

Glaser, John; Denis Foerst, Gerald McKee, Stephan Quave, William Budde. 1981. Trace Analyses for Wastewaters. Environmental Science and Technology. Volume 15, No. 12. Pp 1426-1435.

OTA. 1983. Habitability of the Love Canal Area, An Analysis of the Technical Basis for the Decision on the Habitability of the Emergency Declaration Area.

Sharaf, Muhammod, Deborah Illman, Bruce Kowalski. Chemometrics. John Wiley and Sons. New York. P 122ff.

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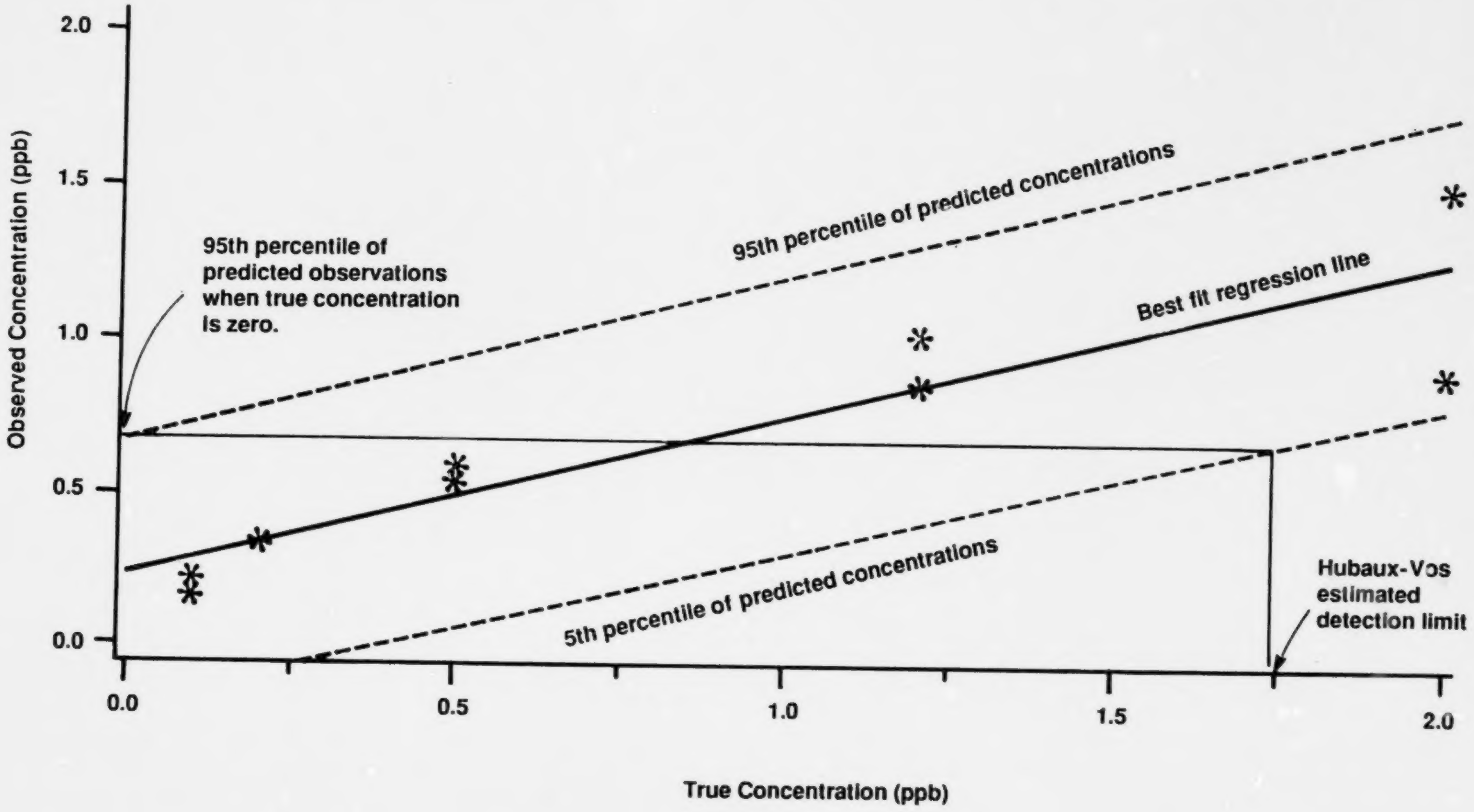

Figure H-1. KEY TO FIGURES H-2 THROUGH H-4

Hubaux–Vos Method Detection Limits by Lab

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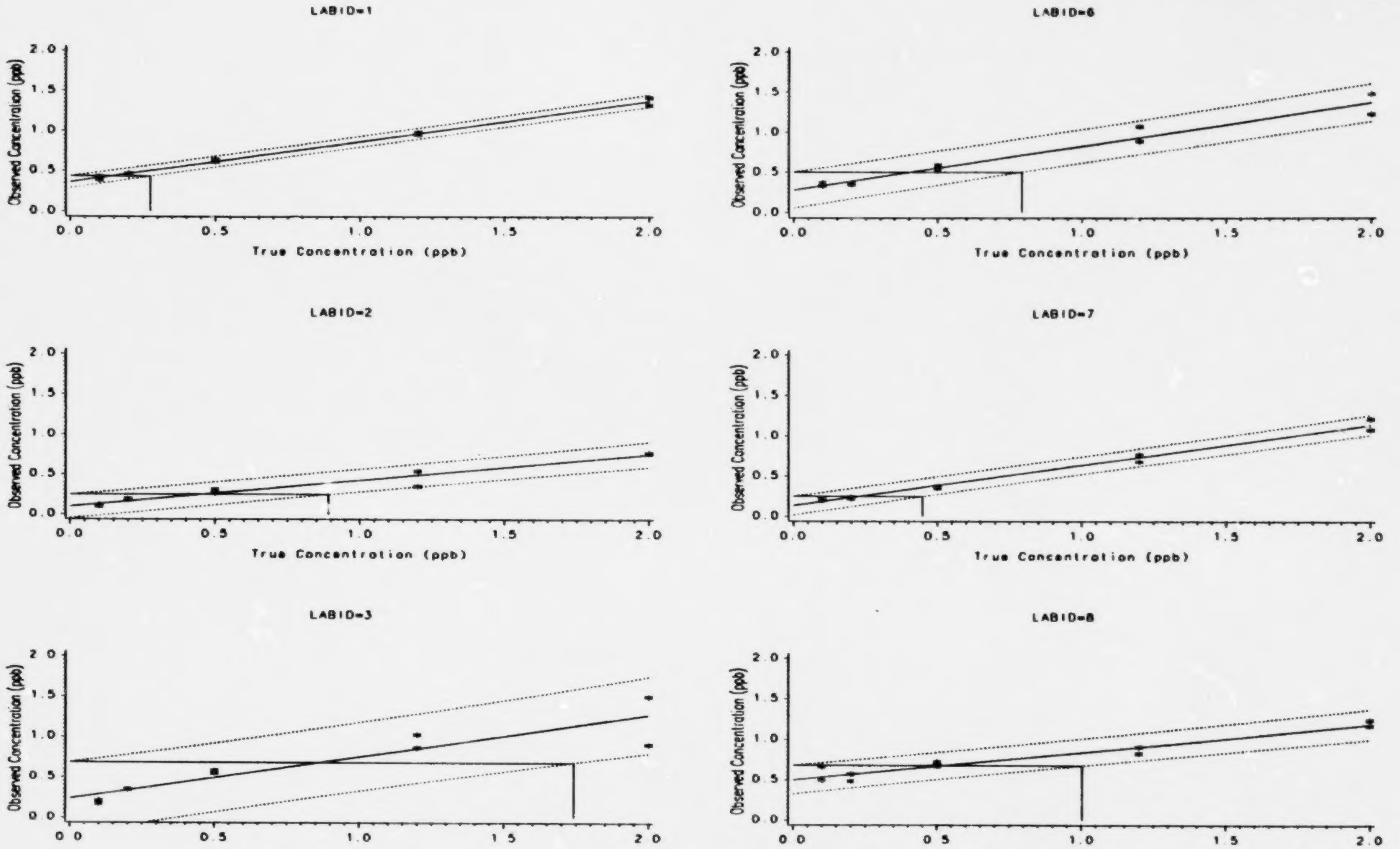

Figure H-2a. ESTIMATE OF DETECTION LIMITS USING PE DATA. (1, 2-DICHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab

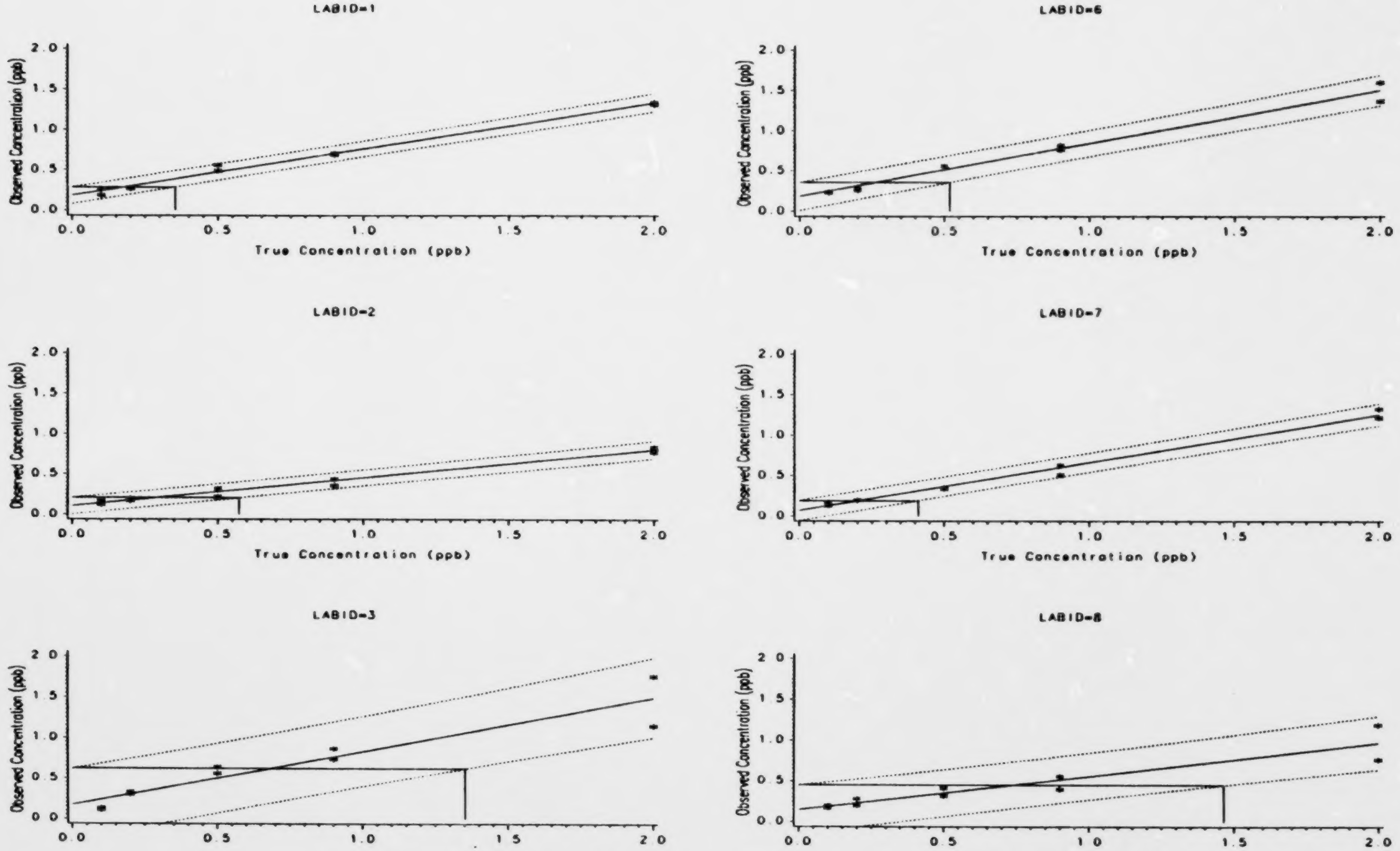

Figure H-2b. ESTIMATE OF DETECTION LIMITS USING PE DATA. (1, 2, 4-TRICHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab

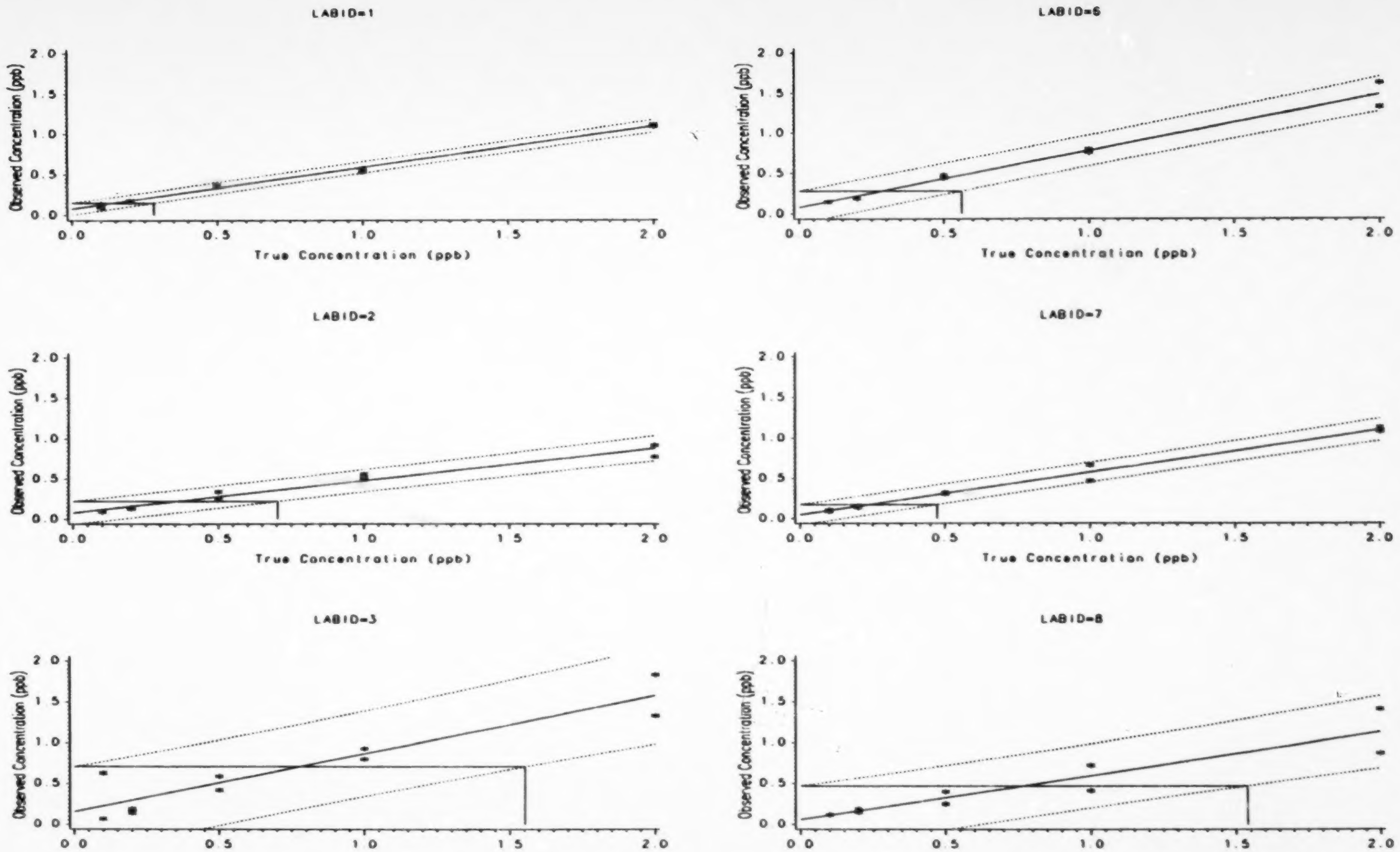

Figure H-2c. ESTIMATE OF DETECTION LIMITS USING PE DATA. (1,2,3,4-TETRACHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab

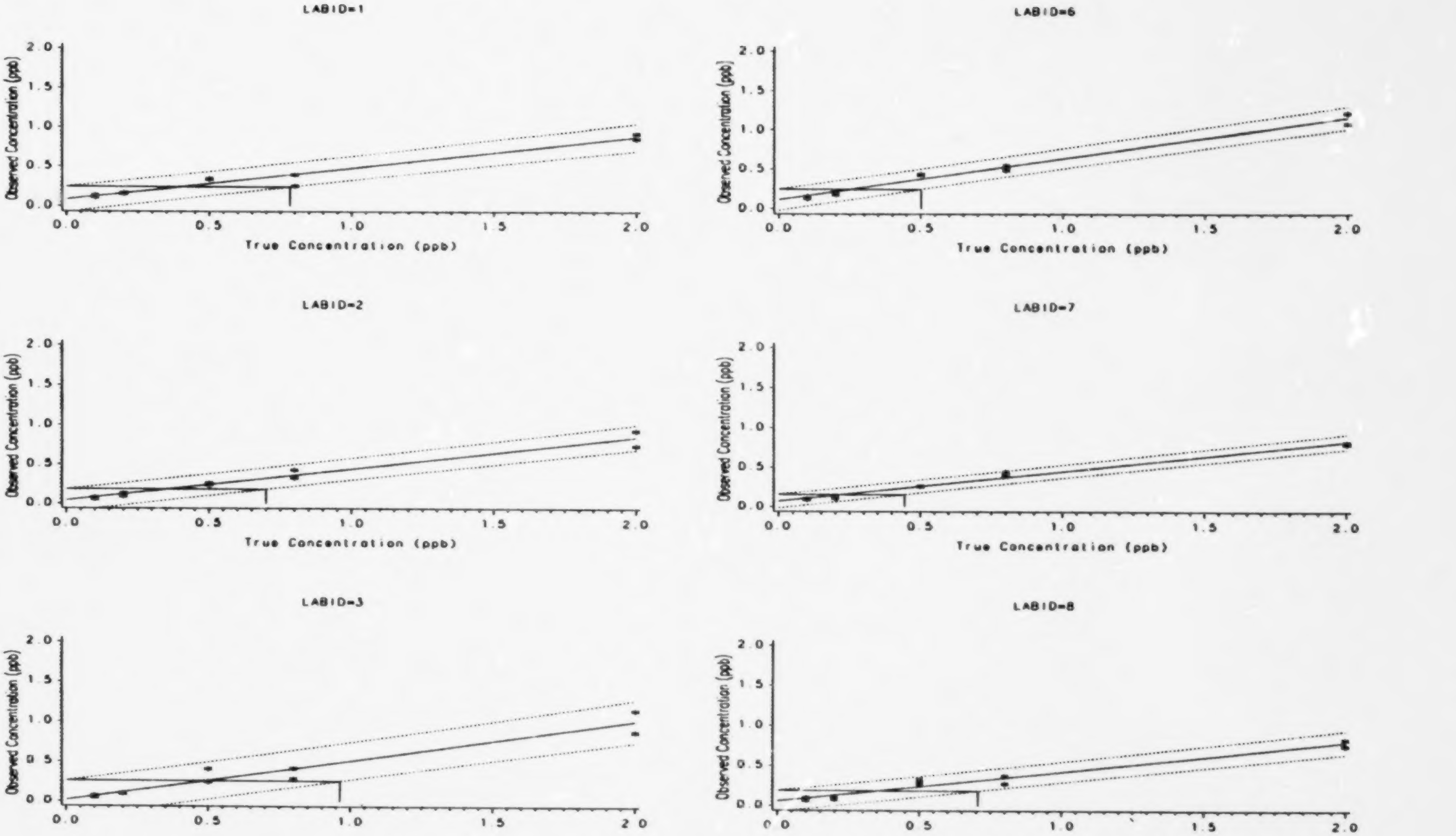

Figure H-2d. ESTIMATE OF DETECTION LIMITS USING PE DATA. (2-CHLORONAPHTHALENE)

Hubaux–Vos Method Detection Limits by Lab

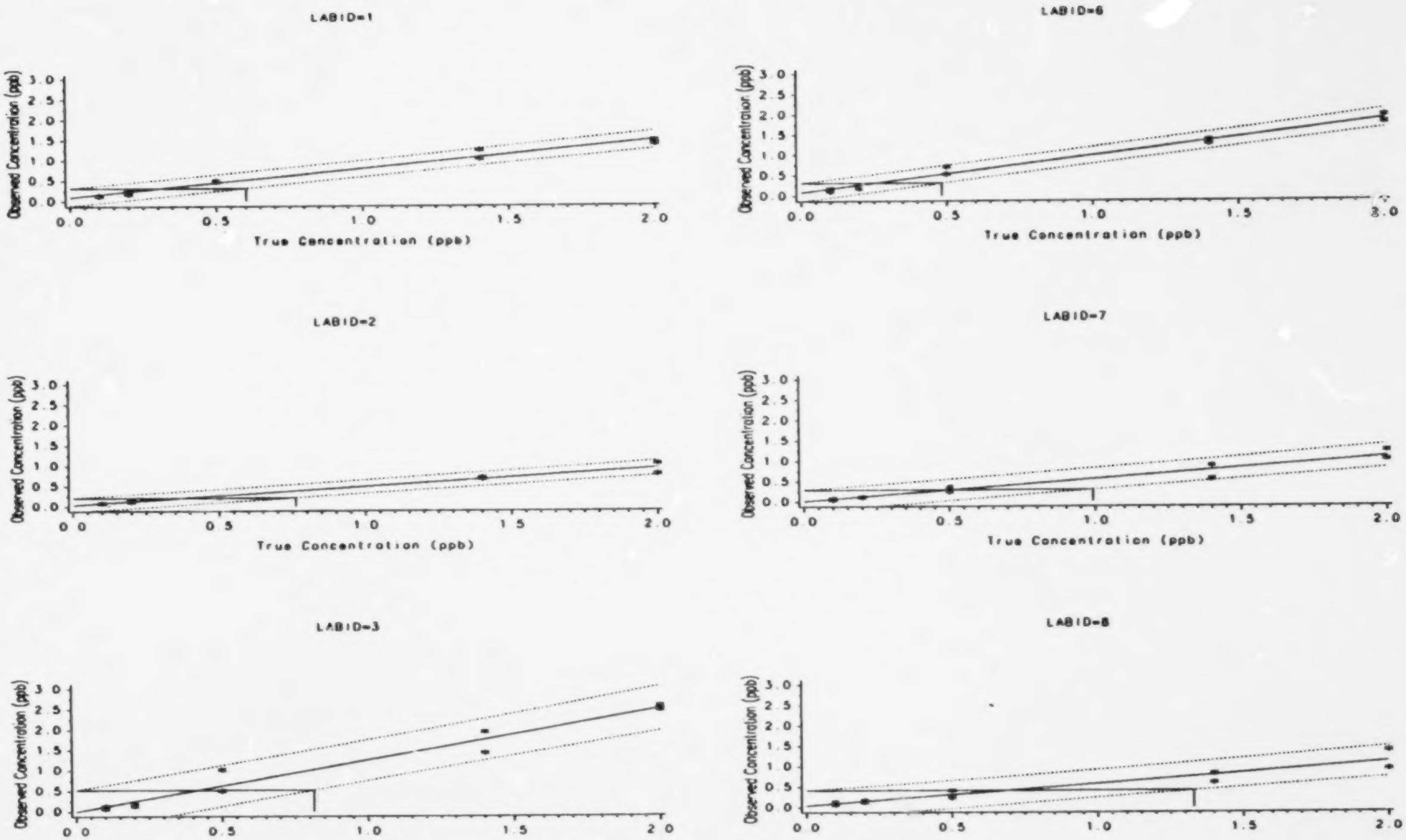

Figure H-2e. EXTIMATE OF DETECTION LIMITS USING PE DATA. (ALPHA-BHC)

Hubaux–Vos Method Detection Limits by Lab

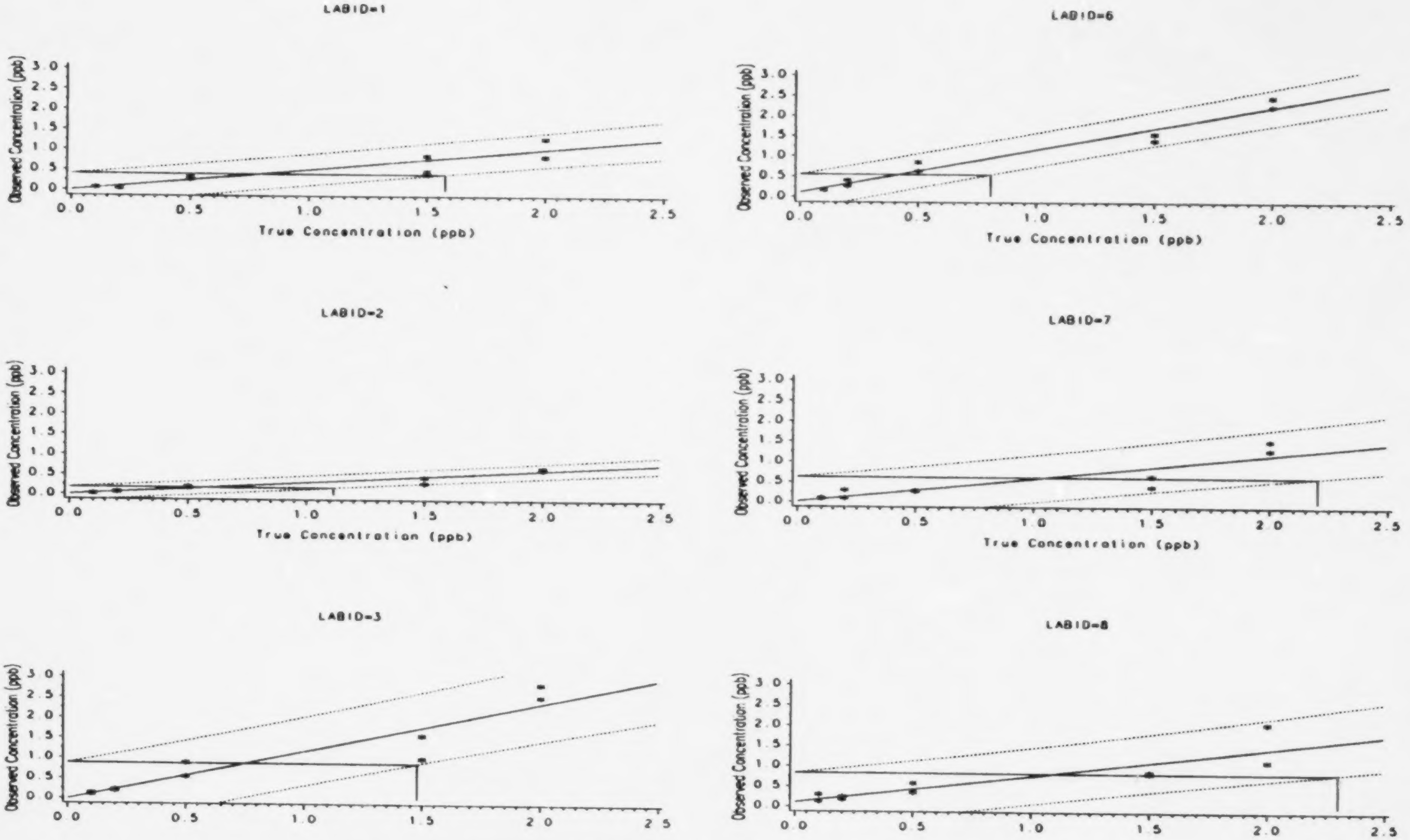

Figure H-2f. ESTIMATE OF DETECTION LIMITS USING PE DATA. (DELTA-BHC)

Hubaux–Vos Method Detection Limits by Lab

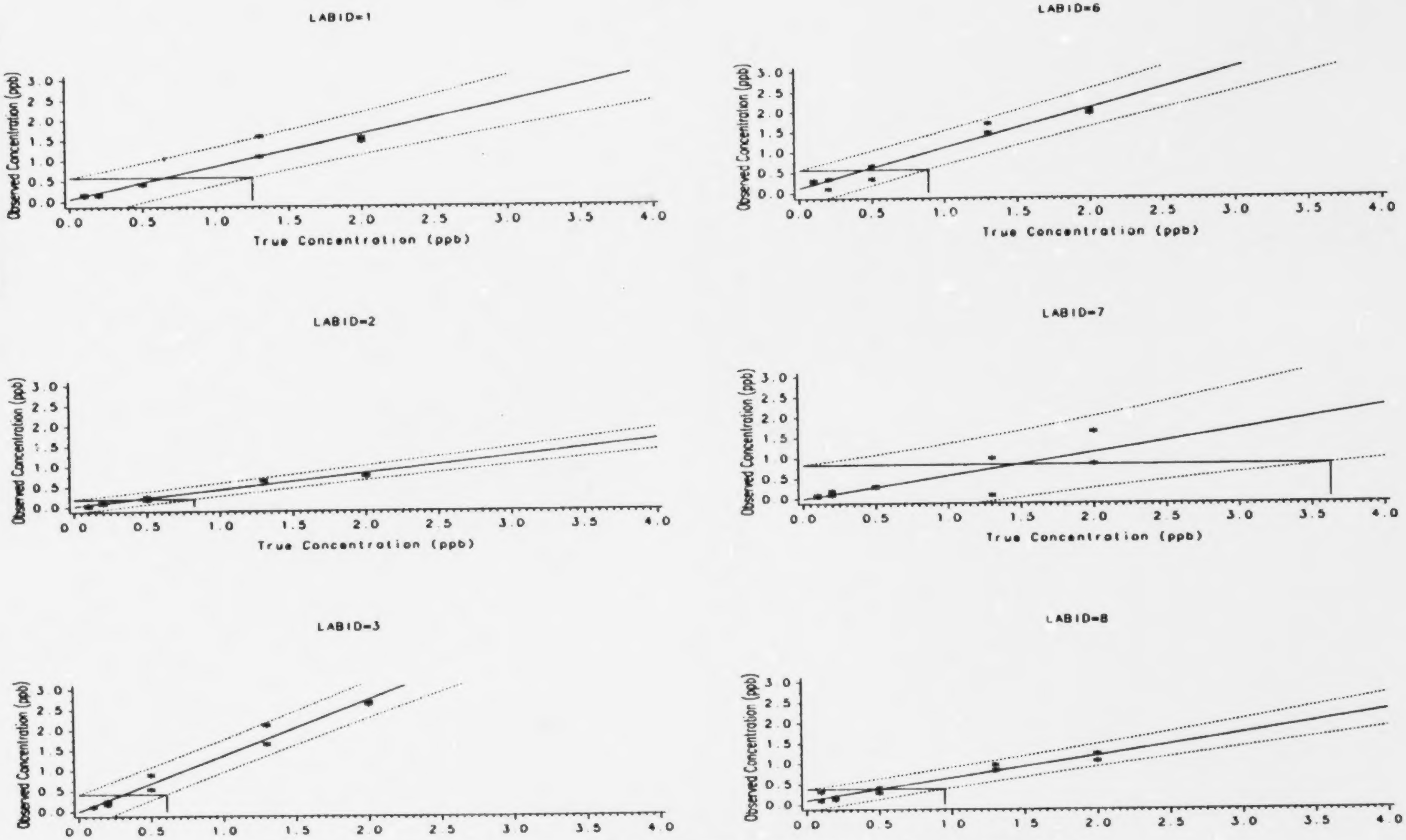

Figure H-2g. ESTIMATE OF DETECTION LIMITS USING PE DATA. (BETA-BHC)

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Hubaux–Vos Method Detection Limits by Lab

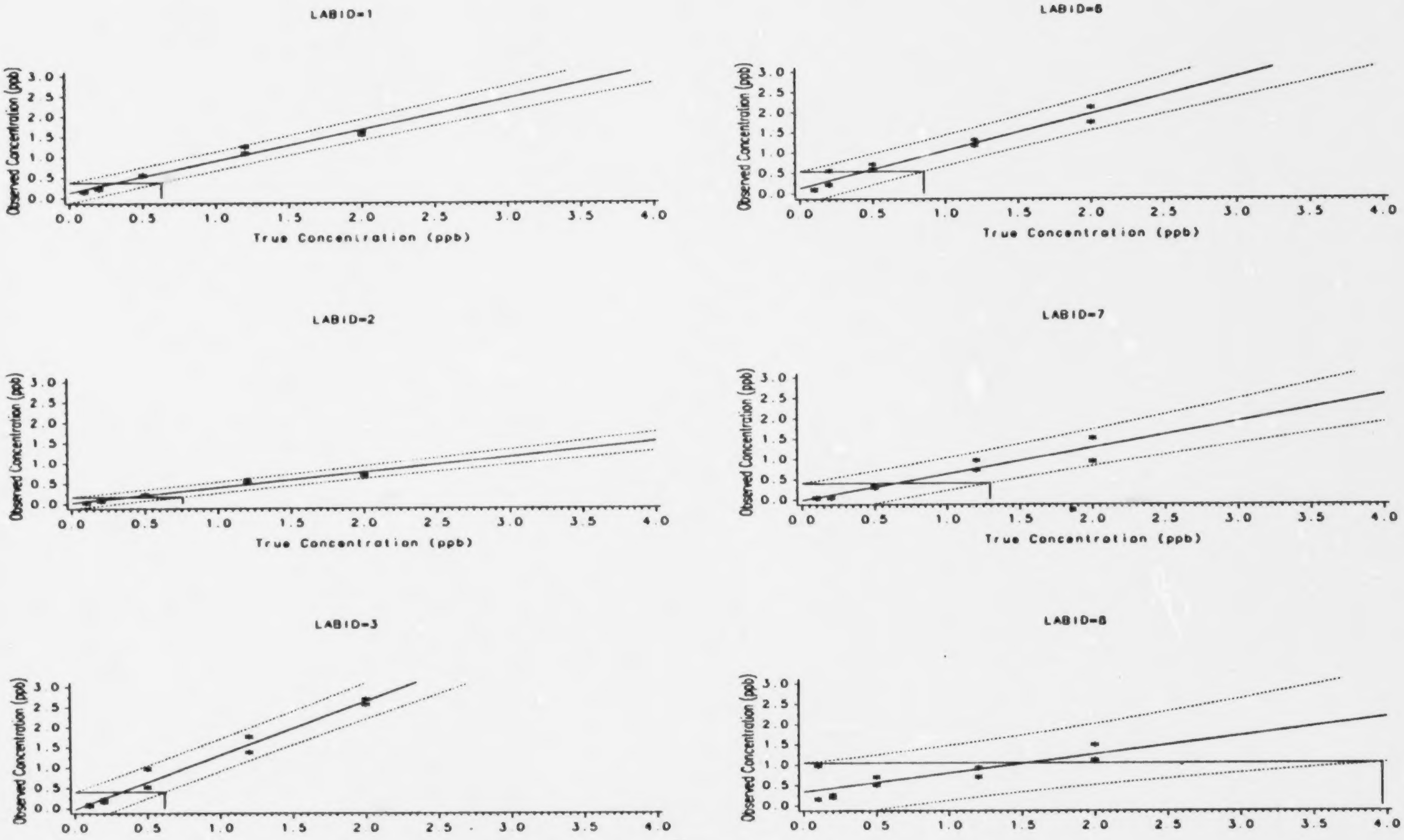


Figure H-2h. ESTIMATE OF DETECTION LIMITS USING PE DATA. (GAMMA-BHC)

Hubaux–Vos Method Detection Limits by Lab

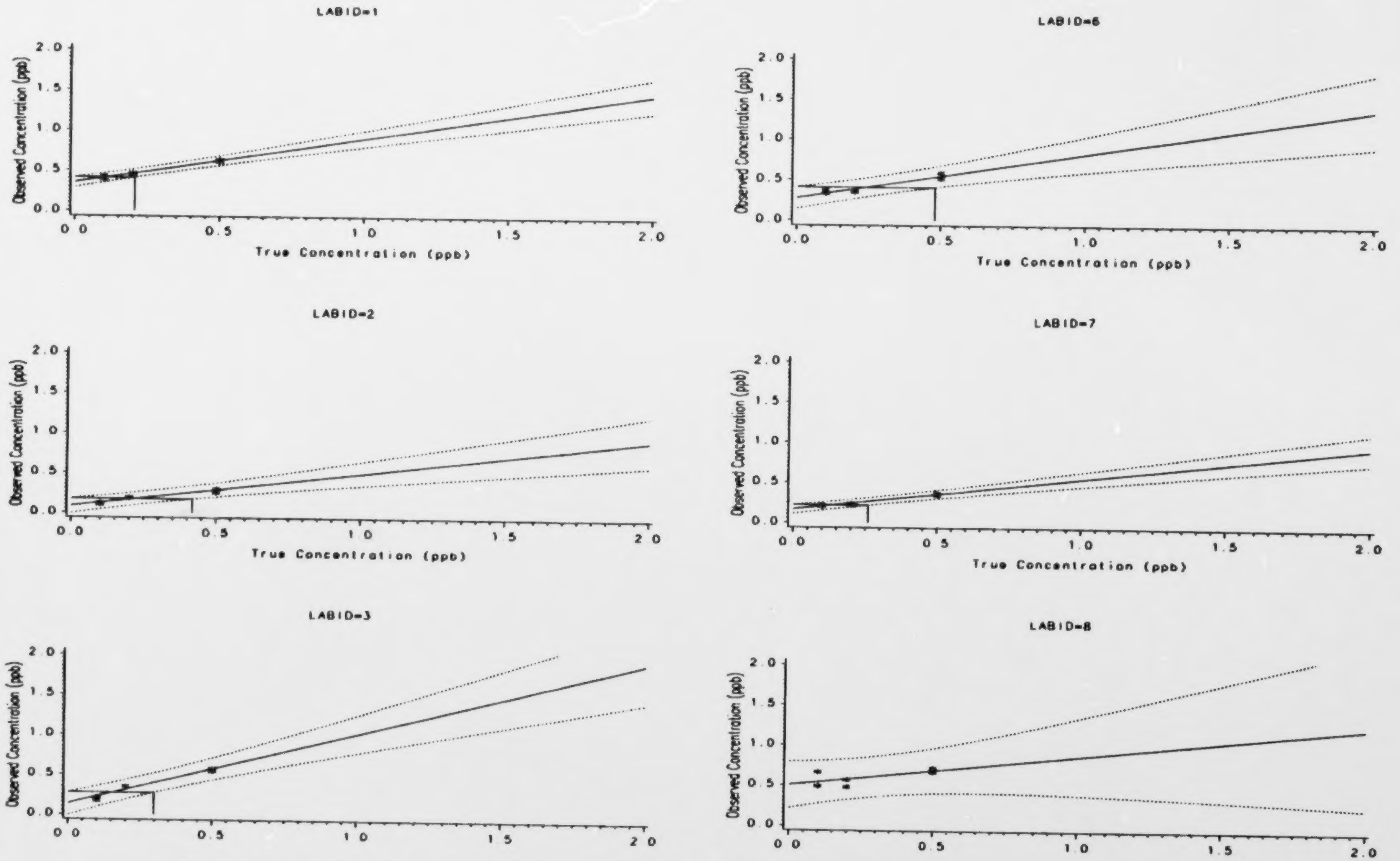


Figure H-3a. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS >1 PPB REMOVED. (1, 2-DICHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab

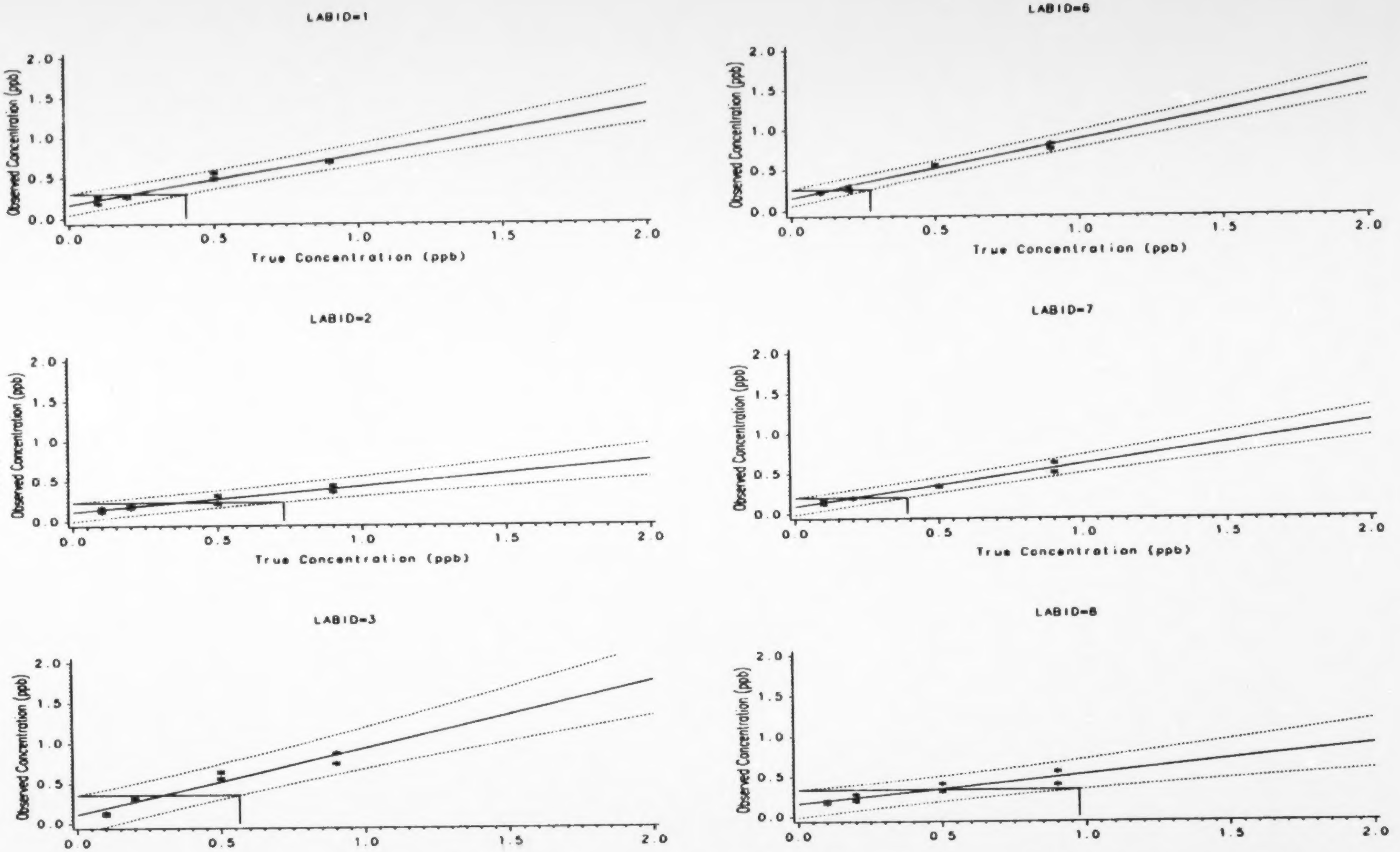


Figure H-3b. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS >1 PPB REMOVED. (1,2,3-TRICHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab

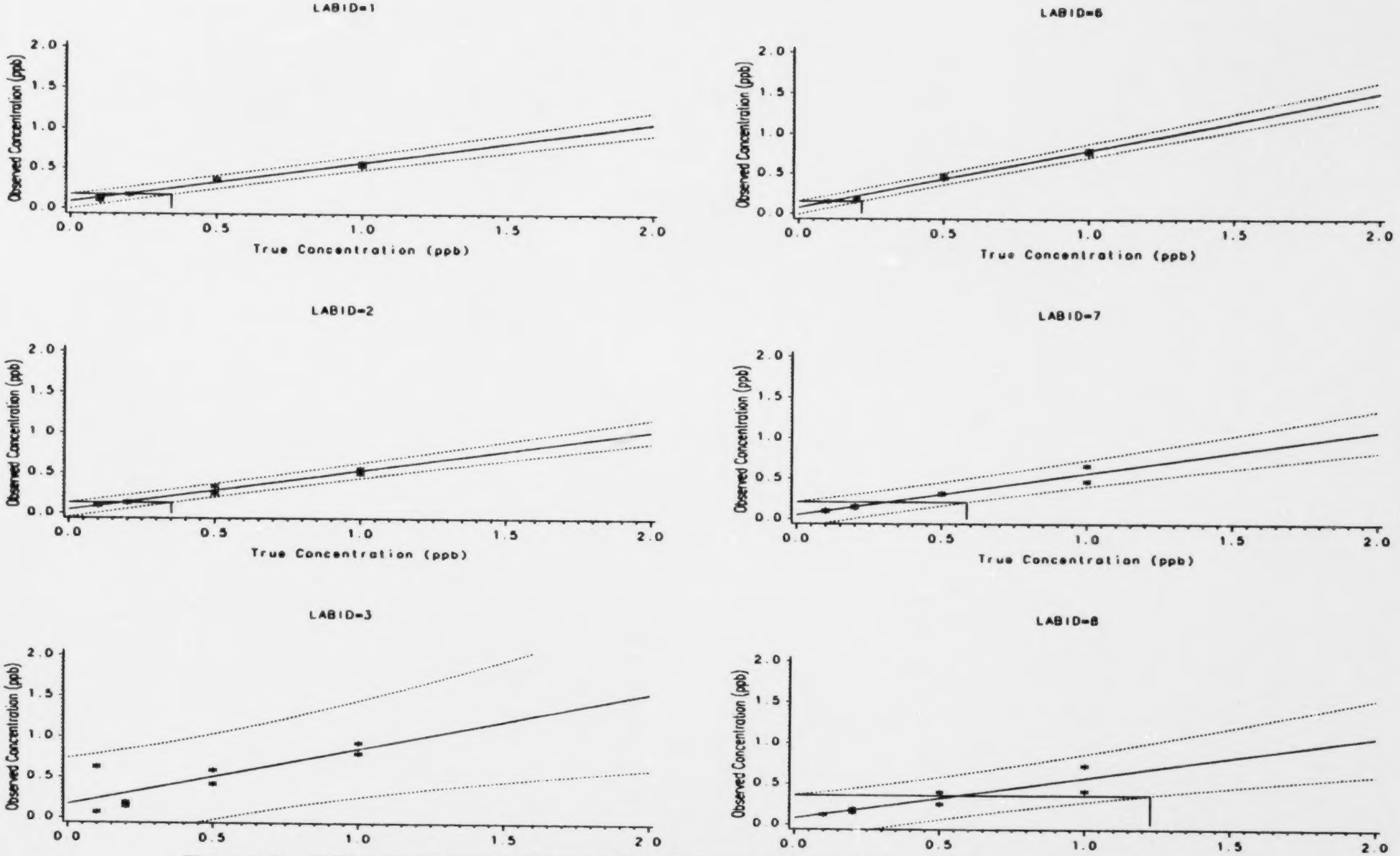


Figure H-3c. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS >1 PPB REMOVED. (1, 2, 3, 4-TETRACHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab

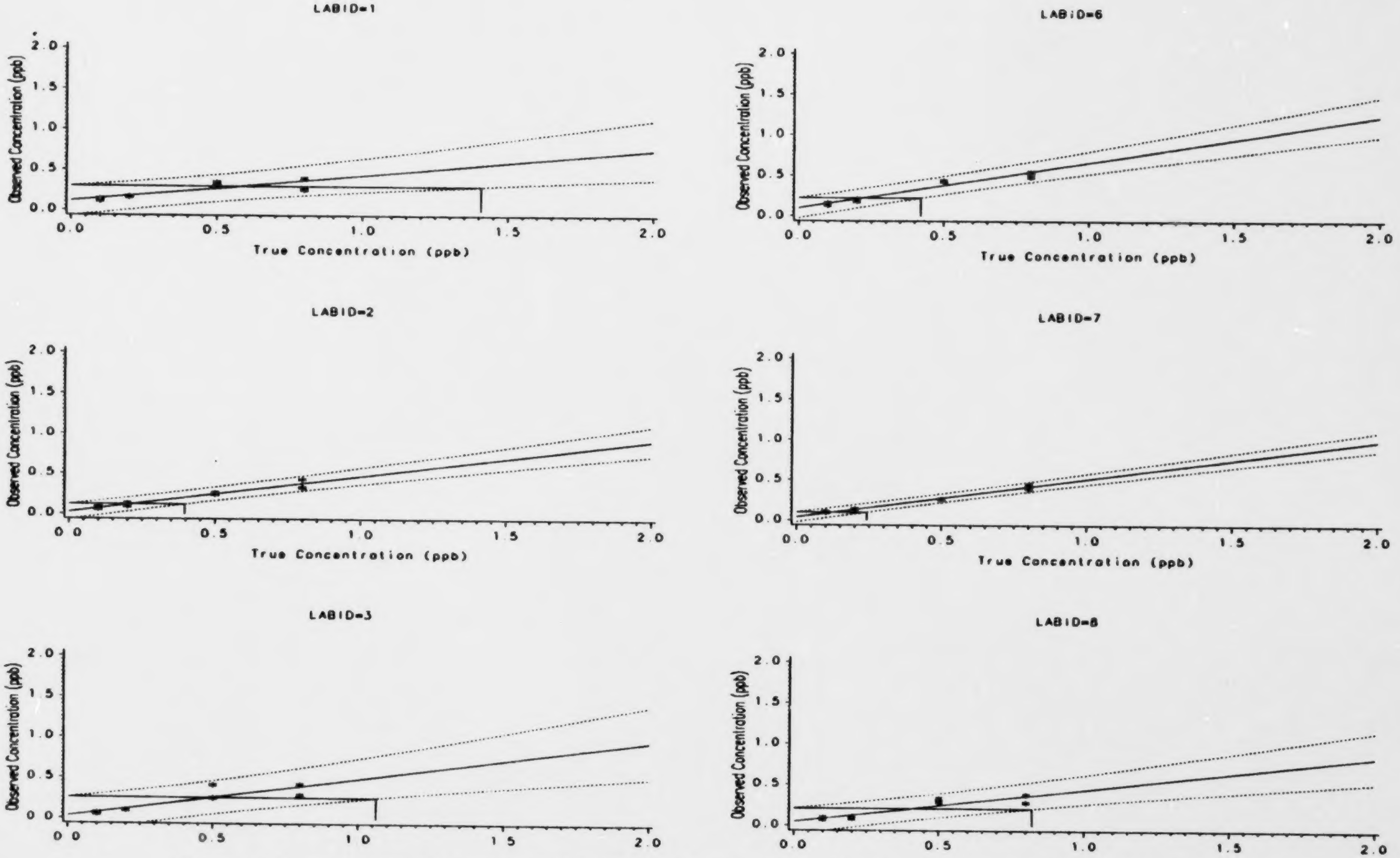


Figure H-3d. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS > 1 PPB REMOVED (2-CHLORONAPHTHALENE)

Hubaux–Vos Method Detection Limits by Lab

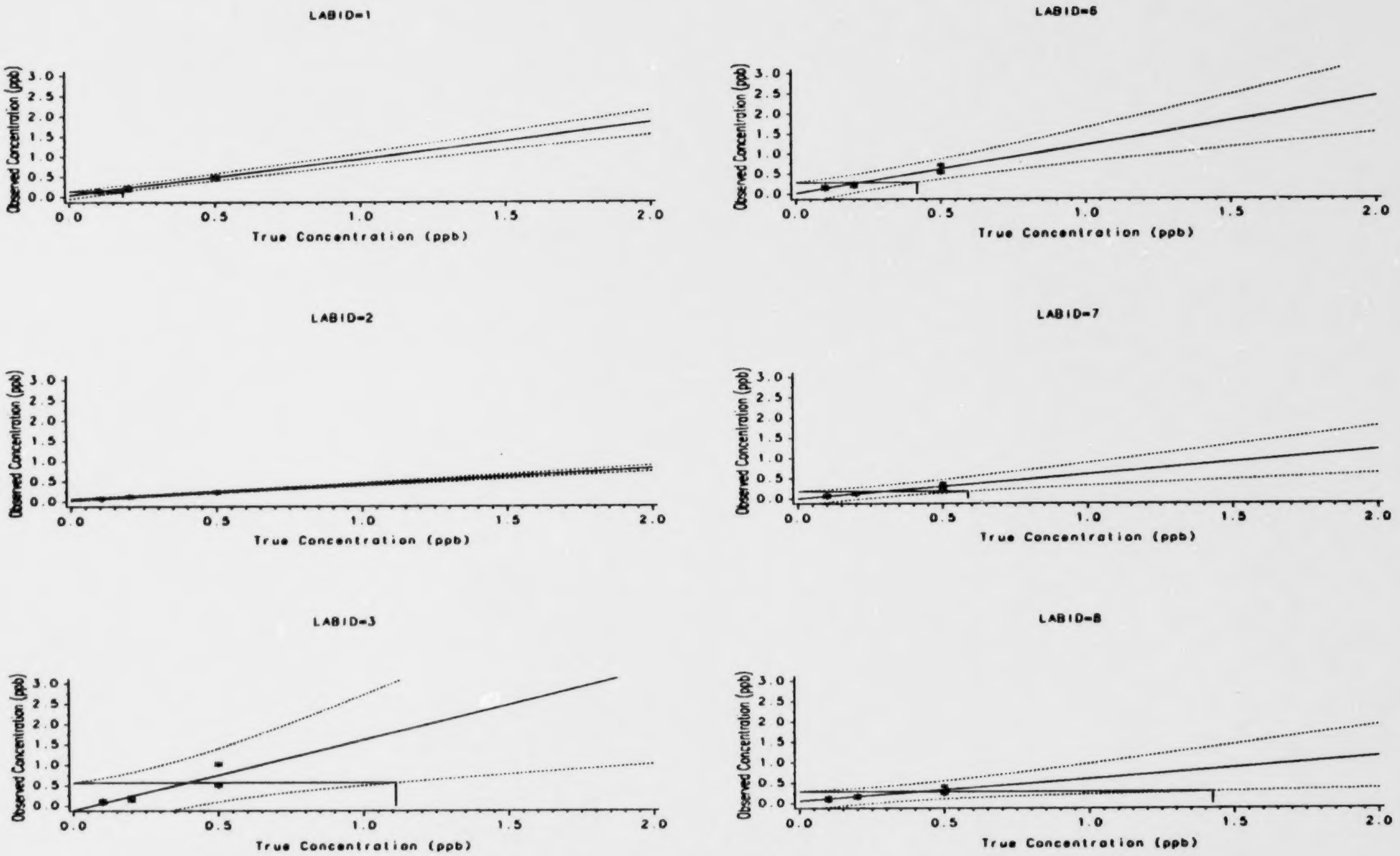


Figure H-3e. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS >1 PPB REMOVED. (ALPHA-BHC)

Hubaux–Vos Method Detection Limits by Lab

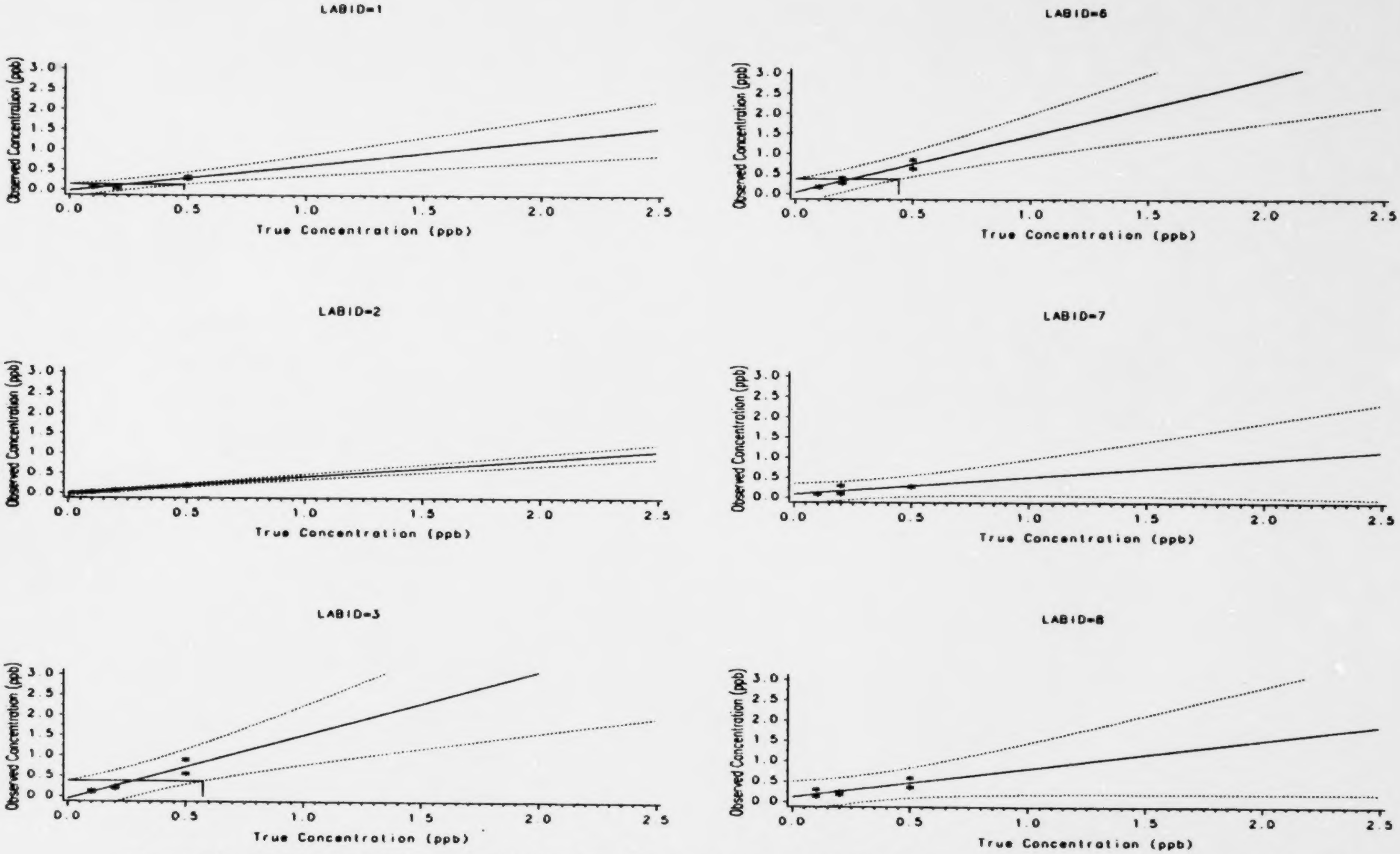


Figure H-3f. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS >1 PPB REMOVED. (DELTA-BHC)

Hubaux–Vos Method Detection Limits by Lab

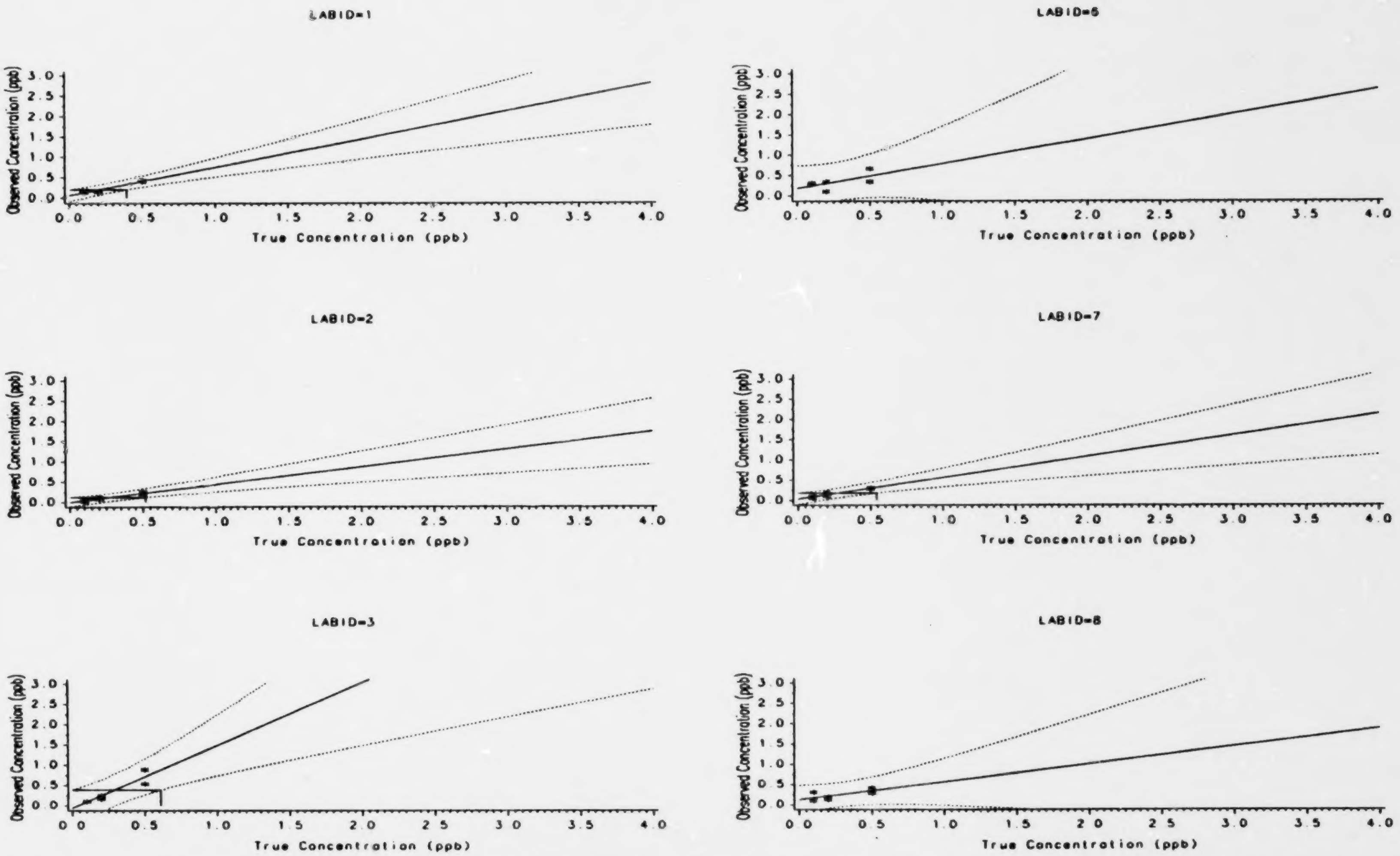


Figure H-3g. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS >1 PPB REMOVED. (BETA-BHC)

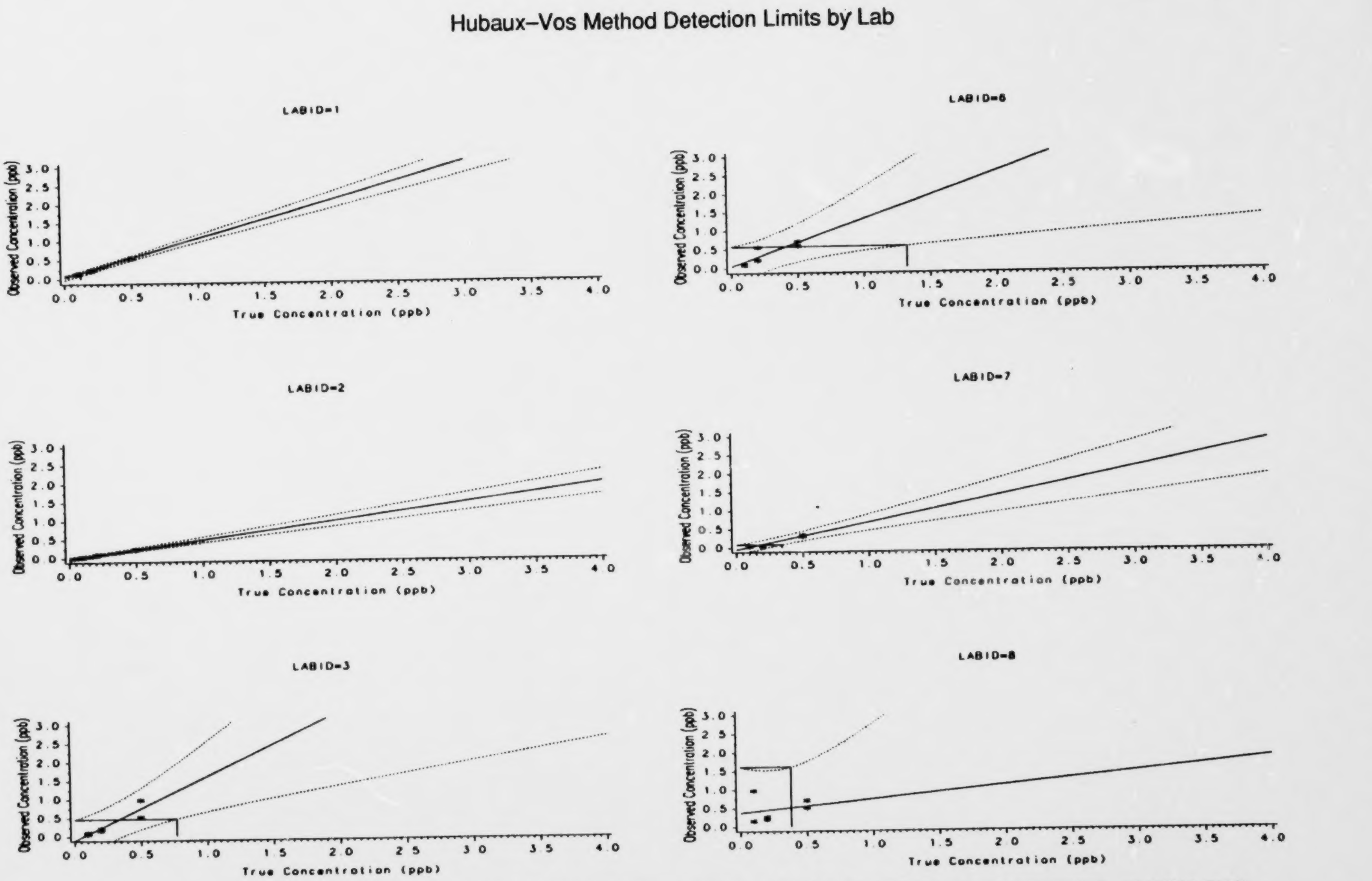


Figure H-3h. ESTIMATE OF DETECTION LIMITS USING PE DATA SET WITH CONCENTRATIONS >1 PPB REMOVED. (GAMMA-BHC)

Hubaux–Vos Method Detection Limits by Lab

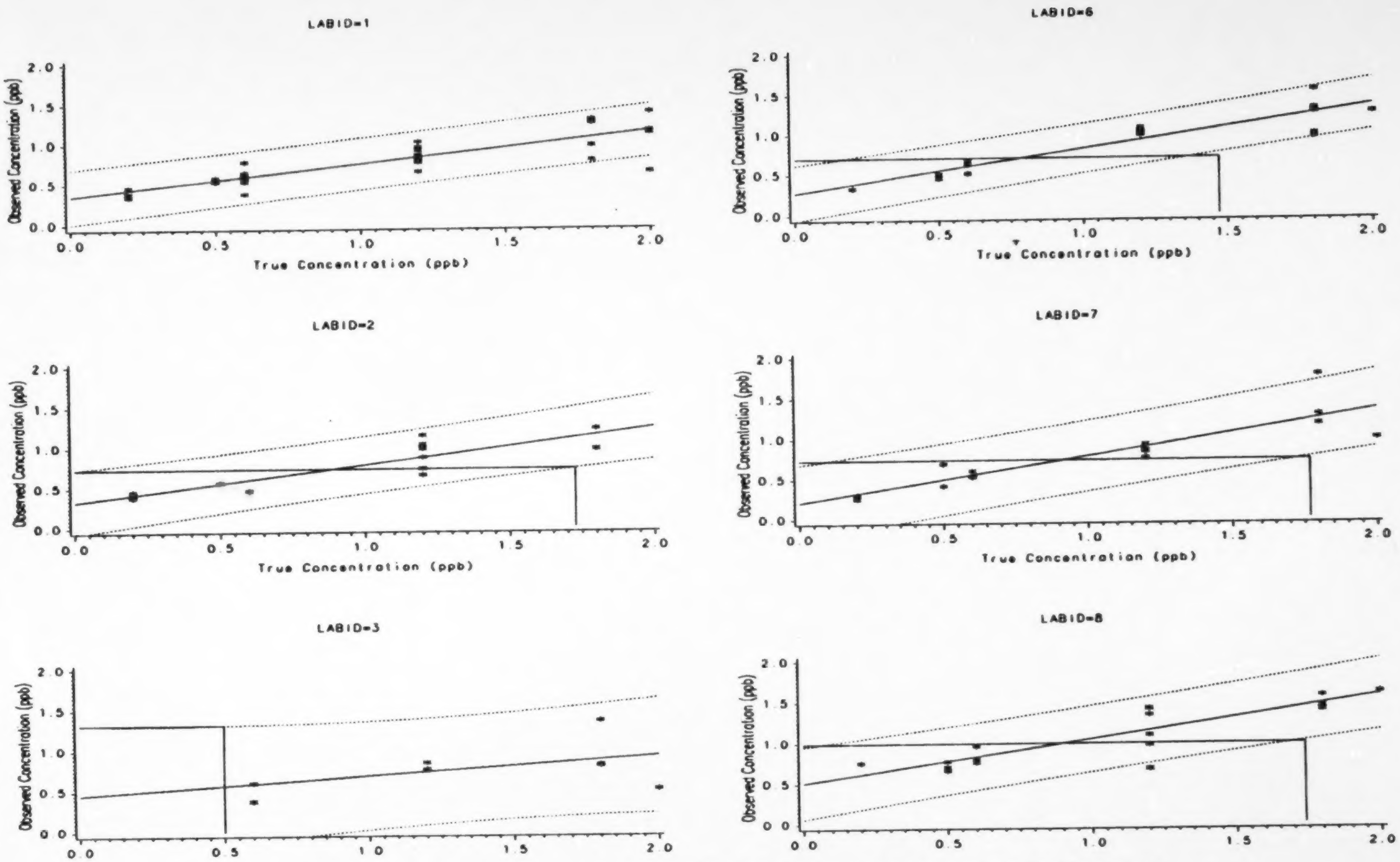
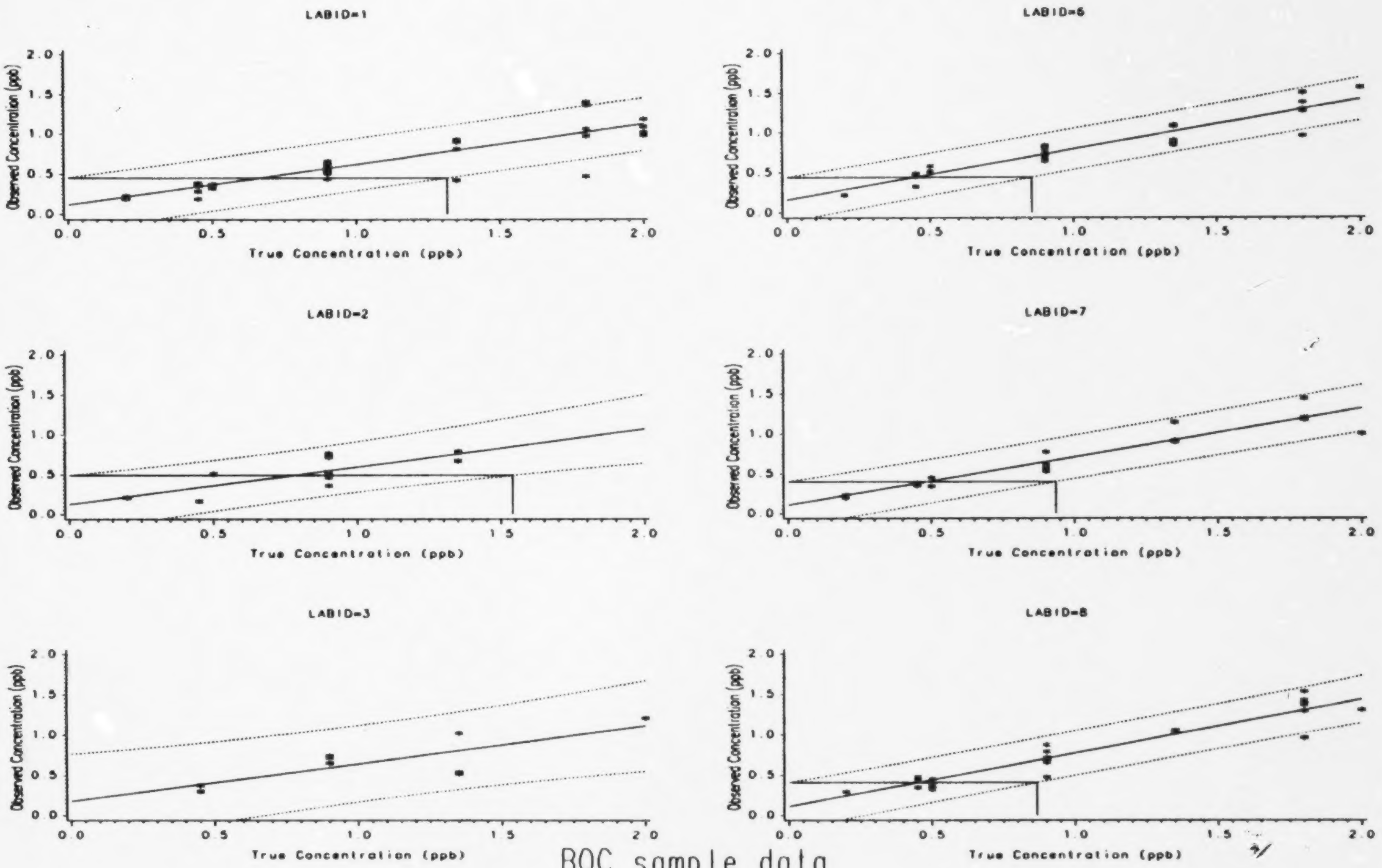


Figure H-4a. ESTIMATE OF DETECTION LIMITS USING BQC DATA. (1, 2-DICHLOROBENZENE)

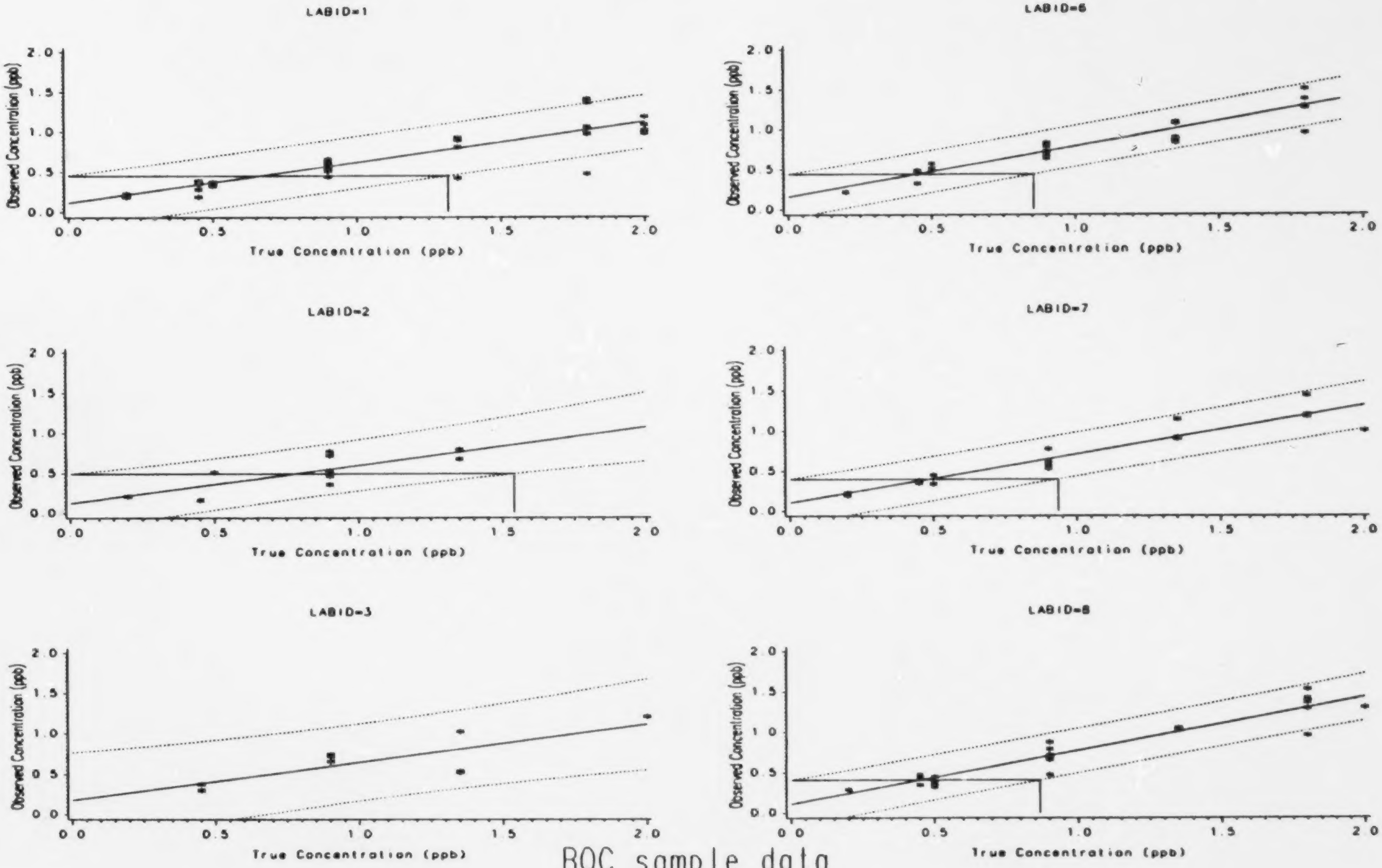
Hubaux–Vos Method Detection Limits by Lab



BQC sample data

Figure H-4b. ESTIMATE OF DETECTION LIMITS USING BQC DATA. (1, 2, 4,-TRICHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab



BQC sample data

Figure H-4c. ESTIMATE OF DETECTION LIMITS USING BQC DATA. (1, 2, 3, 4-TETRACHLOROBENZENE)

Hubaux–Vos Method Detection Limits by Lab

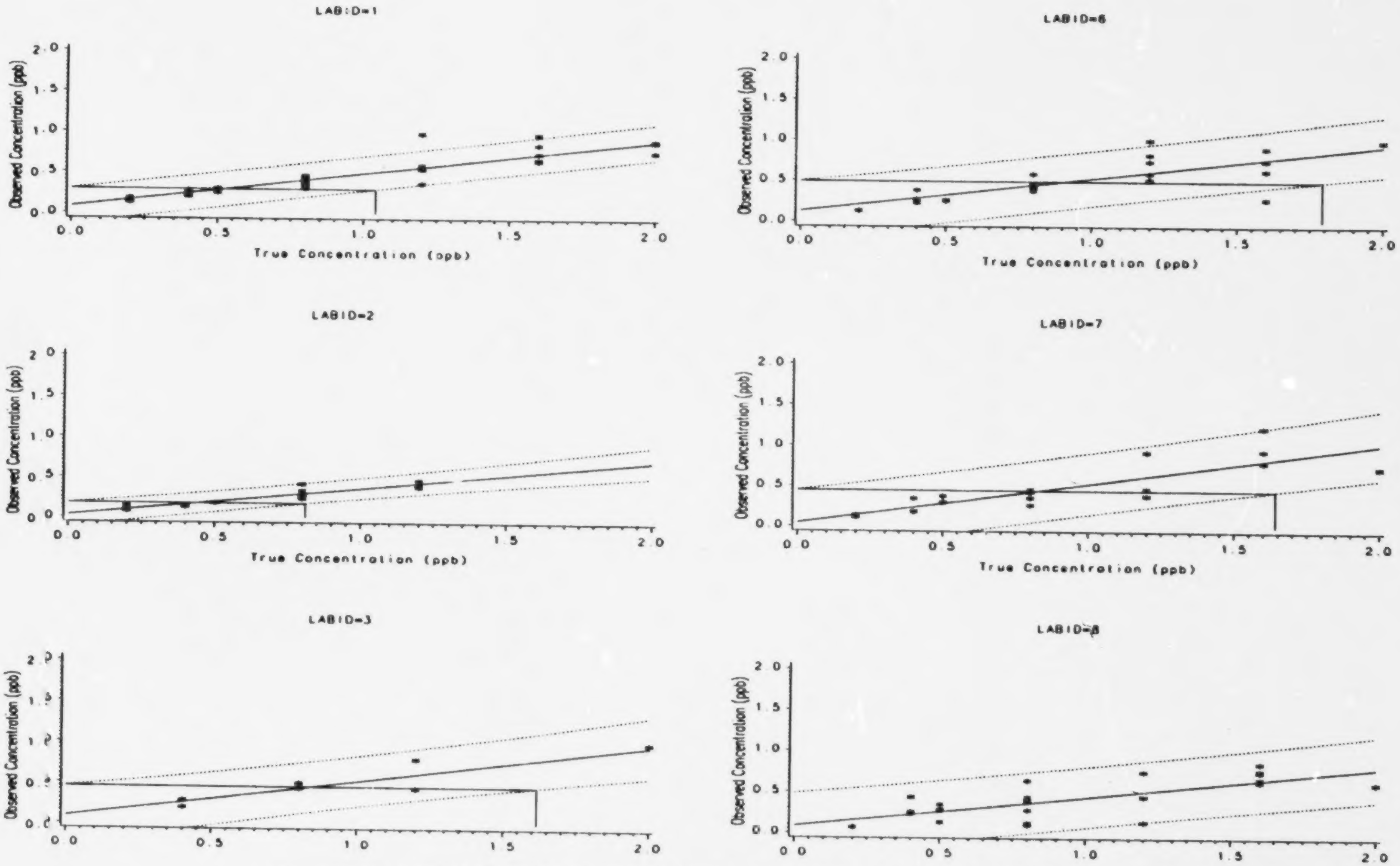


Figure H-4d. ESTIMATE OF DETECTION LIMITS USING RQC DATA. (2-CHLORONAPHTHALENE)

Hubaux–Vos Method Detection Limits by Lab

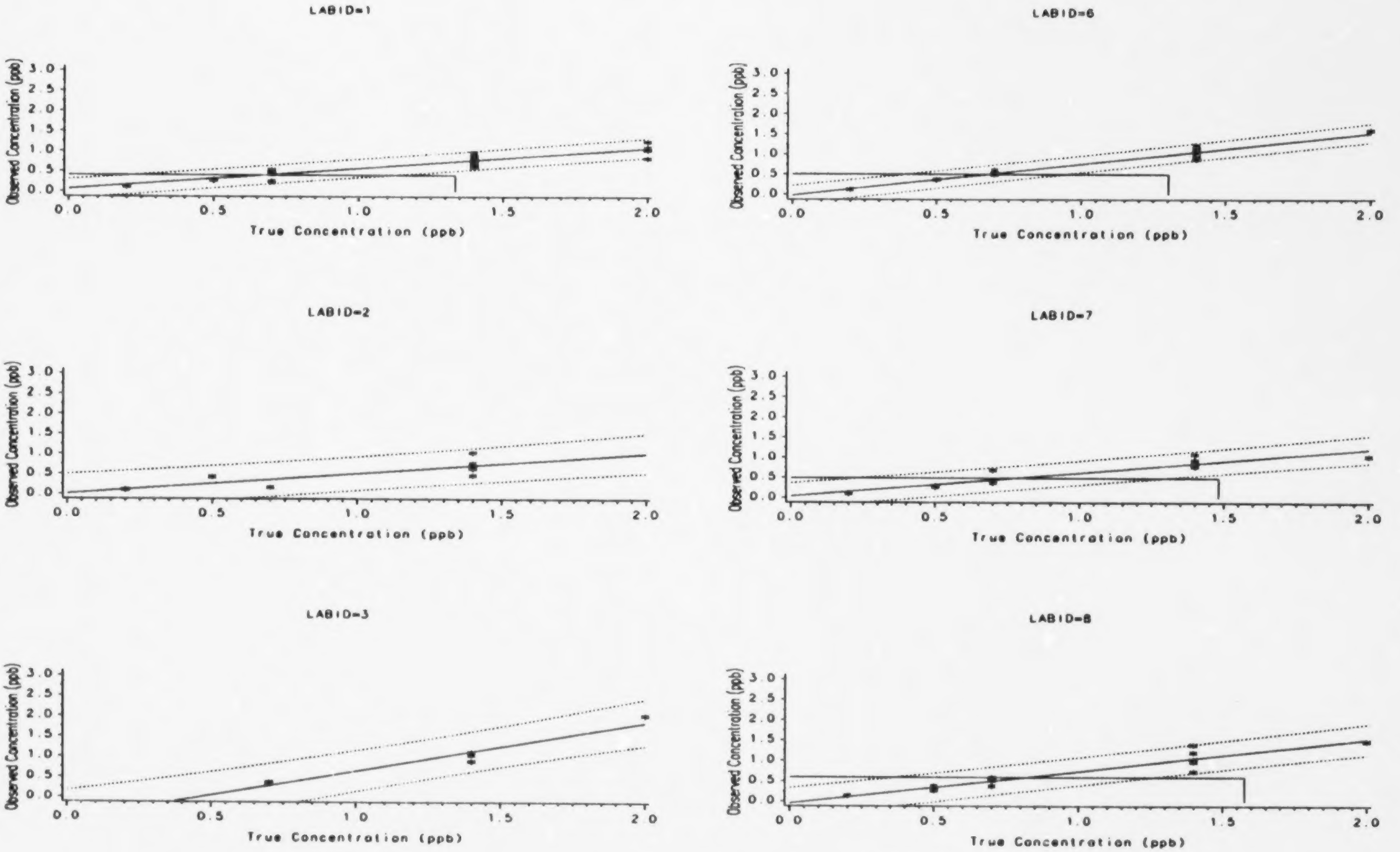


Figure H-4e. ESTIMATE OF DETECTION LIMITS USING BQC DATA. (ALPHA-BHC)

Hubaux–Vos Method Detection Limits by Lab

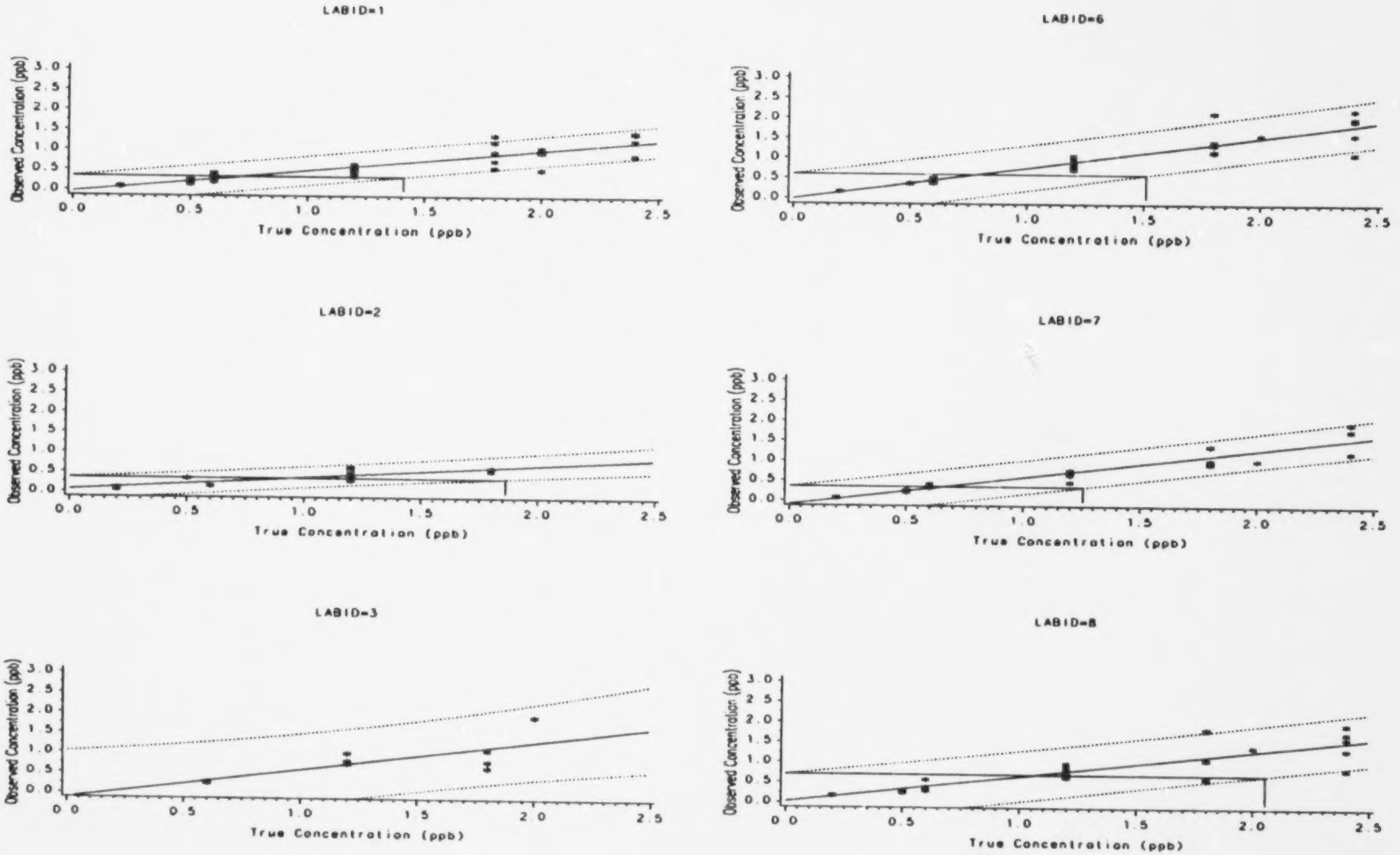


Figure H-4f. ESTIMATE OF DETECTION LIMITS USING BQC DATA. (DELTA-BHC)

Hubaux–Vos Method Detection Limits by Lab

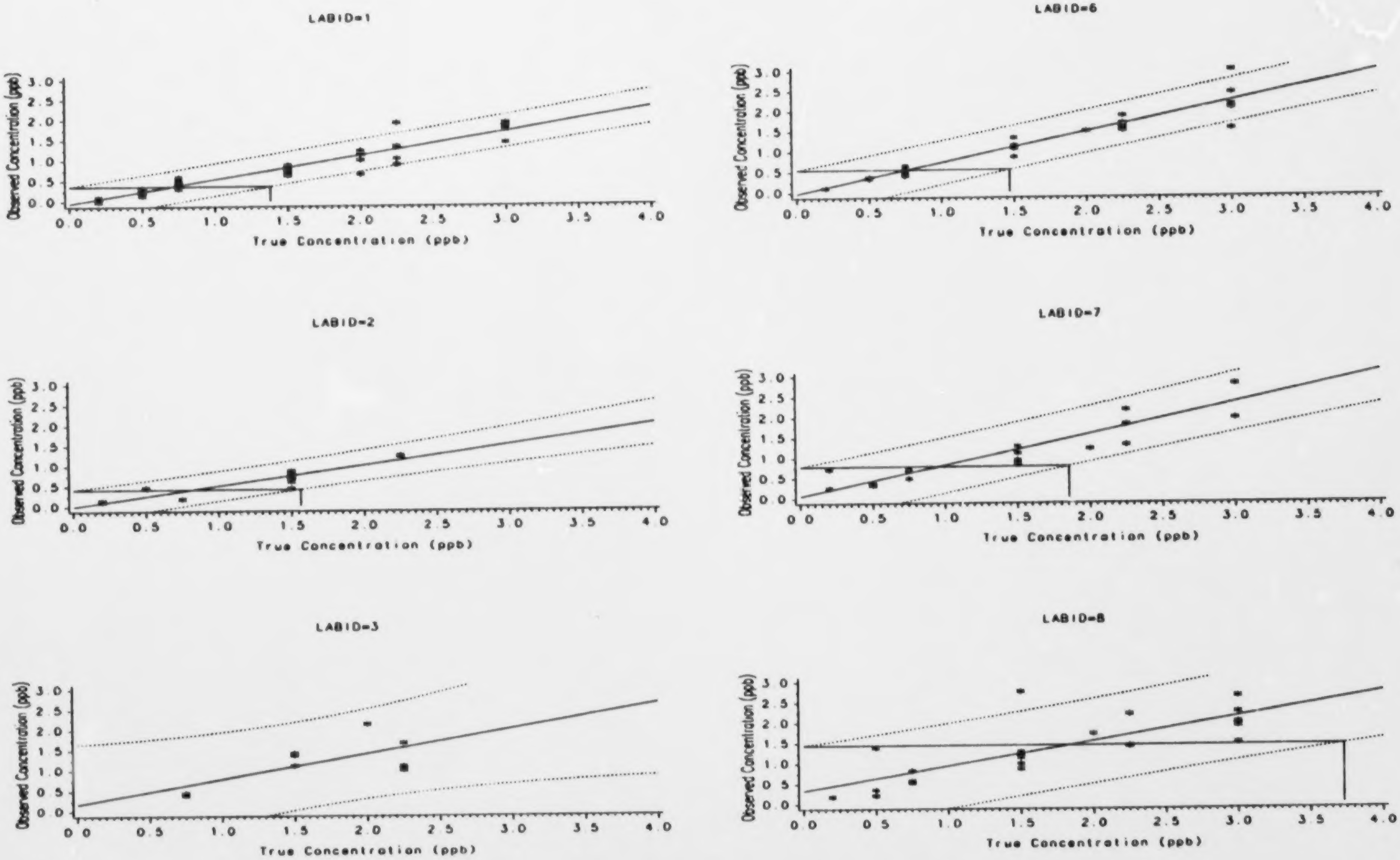


Figure H-4g. ESTIMATE OF DETECTION LIMITS USING BQC DATA. (BETA-BHC)

Hubaux–Vos Method Detection Limits by Lab

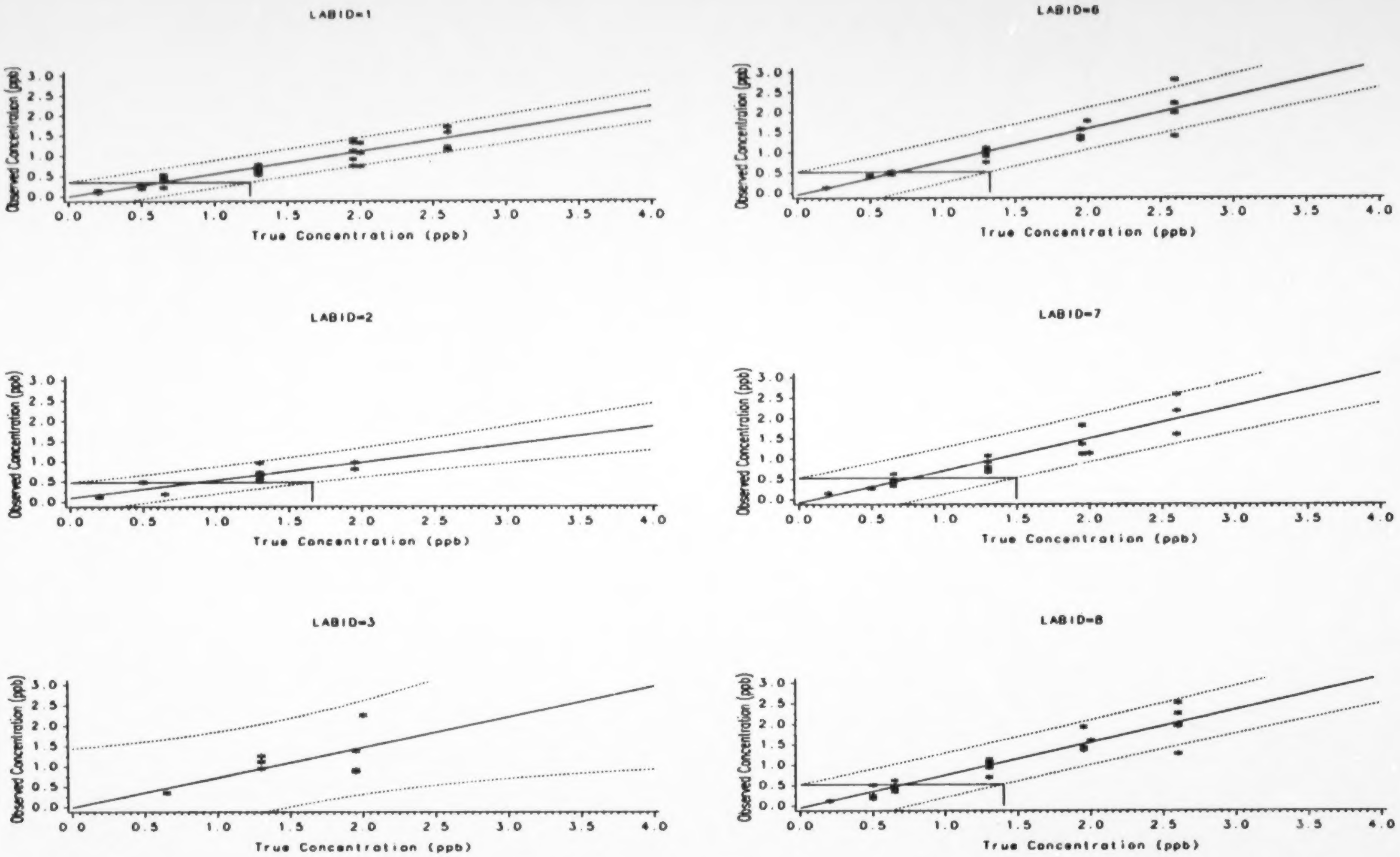


Figure H-4h. ESTIMATE OF DETECTION LIMITS USING BQC DATA. (GAMMA-BHC)

APPENDIX I
Chemical Data Quality Assessment

Soil Assessment--Indicator Chemicals

Appendix I
CHEMICAL DATA QUALITY ASSESSMENT
SOIL ASSESSMENT--INDICATOR CHEMICALS

Since the chemical data quality and the interlaboratory variability were significant issues during the pilot study (CH2M HILL, 1986), the authors feel it is appropriate to expand on the limited presentation of the evaluation of data quality contained in Section 6.2 and Appendix J of Volume III. The soil assessment for indicator chemicals was designed to provide chemical data of known and defensible quality. As this evaluation is important for all future uses of the data, this appendix expands the discussion. Also contained in this discussion are the results of the MHB and FHB analyses requested by Dr. Joan Daisey and the data completeness information requested by Dr. Janick Artiola.

BACKGROUND

Two general approaches are used to assess data quality: classical and chemometric. The classical approach is based on descriptive statistics and the comparison of results against control limits that were determined before the laboratory analyses were initiated. This evaluation is based on the Data Quality Objectives (DQO) of representativeness, completeness, accuracy, precision, and comparability, which were specified before the project was conducted. The chemometric approach (Delaney, 1984; Massart et al., 1988) uses aggregate assessments of data quality. It is conducted as an exploratory data analysis in which large amounts of data are examined using informative graphical presentations to expediently discover biases, differences in variability, or time trends that might not have been adequately controlled in the chemical analysis and that might adversely affect some uses of the chemical results.

The quantitation accuracy was 60 to 80 percent for all LCICs except 2-CNP, for which the accuracy was 50 percent. The within-laboratory precision, as measured using Matrix Spike/Matrix Spike Duplicate (MS/MSD) Relative Percent Differences (RPD), was typically below 20 percent except for 2-CNP, for which the RPD averaged 20 to 40 percent in five of the six laboratories performing chemical analysis. The between-laboratory precision, as measured using field-split samples, was below 50 percent for the non-BHC LCICs and was in the range of 40 to 70 percent for the BHC LCICs.

Quantitation of 2-CNP appears to be less stable and biased lower than the other LCICs. While this difficulty is not expected to seriously affect the statistical comparisons for habitability, alternative uses of the 2-CNP results should be made with caution.

Laboratory 6 had the most consistent performance, as evidenced by high accuracy and precision. Laboratory 1 had high precision but was biased slightly low relative to the other laboratories. Laboratory 3 displayed consistent evidence of increased variability relative to the other laboratories.

Both the classical and the chemometric assessment support the conclusion that there were no major defects in chemical data quality. Within the constraints of the preset control limits for each QC measure, there were subtle differences in accuracy, precision, and comparability from one laboratory to another. With the minor exception of the advisory recovery limits for matrix spikes, all laboratories were able to meet the DQOs.

APPROACH

The chemical data from the soil assessment for indicator chemicals are examined in terms of the five DQOs: representativeness, completeness, accuracy, precision, and comparability. This examination includes both qualitative descriptions and quantitative reporting of results. (The DQO of sensitivity is discussed in Appendix H, which discusses detection limits.)

Each of the five DQOs is presented separately in the following section. A familiarity with the chemical analysis method used in the soil assessment for indicator chemicals and with the concepts of analytical chemistry and statistics is assumed.

Chemometric and statistical tools were used for visual examination of the data. Box plots and trend plots were employed to readily facilitate the examination of a large amount of data. The laboratories are indicated on these plots by numbers 1 through 8. (Laboratory 5 is not shown and ultimately did not participate in the study; samples prepared by Laboratory 4 were analyzed by Laboratory 1.) Where appropriate, control limits are indicated by horizontal lines. On the box plots, points that are beyond the range of the plot are included by numerical annotations. (See page 6-18 of Volume III for more details on how to read box plots.) On the trend plots, a least squares regression line has been fit to the data. The vertical lines indicate the dates of initial calibrations.

This appendix includes summary tables of the laboratory performance and examples of the box plots and trend plots used to examine the chemical data. At each reference to an example figure in the text, a parenthetical note is given describing the specific example provided. These examples are included to show the reader the form of data presentation. The entire set of figures was used to develop the observations and comparisons that are discussed in the text of this appendix.

DISCUSSION

As stated previously, the soil assessment for indicator chemicals was designed to provide data of known and defensible quality. To achieve this goal, several data QA/QC objectives were selected; these objectives relate to the data's representativeness, completeness, accuracy, precision, and comparability.

Representativeness is discussed in terms of the number of samples collected and analyzed in the study.

Completeness of the field sample data has already been discussed in Volume III. Statistically useful results were obtained for 85.7 percent of the samples analyzed in the study. Completeness of the QA/QC data is assessed in terms of the number of QA/QC analyses that meet the specified QC criteria. Tabulations of these results are presented.

Both accuracy and precision are examined in three ways. First, a summary table of descriptive statistics is presented for each of the QC measures that relate to accuracy or precision. Second, examples are given to show the qualitative assessment of accuracy and precision performance displayed by the participating laboratories. Finally, a quantitative, statistically based statement is made regarding the accuracy or precision of the data from this study.

Comparability of the data produced by each of the participating laboratories has been assessed by studying box plots of a wide variety of instrument and method performance measures. Time-series trend plots have been used to determine the extent to which various chemical analysis parameters, such as surrogate recoveries and relative response factors, remained stable for the duration of the laboratory analysis phase of the project.

The following paragraphs assess whether these QA/QC objectives have been achieved.

REPRESENTATIVENESS

To obtain representative samples, the sampling design specified that sample collection be randomly allocated among collection teams and neighborhoods. A detailed discussion of the sampling design to achieve the sample representativeness can be found in the sample collection and preparation QAPP (CH2M HILL, 1987a). As indicated by Table I-1, a total of 879 field samples were collected out of the 894 planned. These soil samples were collected from the seven sampling areas of the EDA and the three comparison areas (Cheektowaga and Tonawanda combined, Census Tract 221, and Census Tract 225). The agreement between the actual and planned sample allocations confirms that the original randomization was maintained with respect to the sampling crew and sample analysis laboratory. The representativeness criterion, as described in the design of the sampling program, was achieved.

COMPLETENESS

Of the 879 field samples collected and sent to seven analytical laboratories for analysis of the LCICs (Table I-1), 781 samples were actually analyzed; 97 samples were not analyzed because of problems at Laboratory 4, and one sample was not analyzed at Laboratory 3. In addition to the regular field samples, two types of field QC samples were collected and analyzed by the laboratories. Table I-2 shows the number of field samples and field QC samples that were analyzed by each laboratory.

After the sample analysis, the electronic and hardcopy data provided by the laboratories were subjected to a detailed data assessment by EMSL-LV. As a result, an assignment of data qualifiers were assigned to each sample and each LCIC analyte within a sample. Each LCIC result was defined as Good, Uncertain, or Bad. Table I-3 gives the percentage of the Good, Uncertain, and Bad summary qualifiers for each laboratory. As shown in Table I-3, the total Bad data of only 6.6 percent indicate the excellent performance of the laboratories using a method of this complexity.

Table I-4 summarizes the laboratory QC samples required by the QA/QC program and analyzed by the laboratories to improve the reliability of the data. In addition to these QC samples, other QA/QC measures, e.g., surrogates, internal standards, etc., as specified in the analysis QAPP (CH2M HILL, 1987b) were also performed by the laboratories. QC control limits were set for the various measures of these QC samples. The QAPP-specified goal was that the laboratories should meet the QC control limits for either 90 percent or 100 percent of the analyses, depending on the type of QA/QC measures involved. Table I-5 summarizes the results of all QC sample data. The results from all field, field QC, and laboratory QC samples are included and summarized in the table.

As shown in Table I-5, the QAPP-specified goal was met for all types of QA/QC measures, with the minor exception of MS/MSD analyses, which had advisory control limits. The results of these QA/QC measures indicate that the analytical program was successfully implemented within a constraining schedule and heavy sample analysis load. The laboratories, in general, followed the QA/QC requirements, as specified in the analysis QAPP. This increases the confidence of the results reported by the laboratories.

ACCURACY

For this study, accuracy has been assessed using three types of measures: surrogate recovery, matrix spike recovery, and BQC sample recovery. The MHB and FHB results have also been examined for evidence of bias. Three surrogate standard compounds, 1,4-dibromobenzene (DBB), 2,4,6-tribromobiphenyl (TBBP), and 1,2,4,5-tetrabromobenzene (TeBB), were spiked into each field sample and QC sample at the beginning of the sample preparation process. While they are not LCICs, the surrogate compounds were chosen to mimic the behavior of the LCICs during sample preparation and analysis. 1,4-DBB and 2,4,6-TBBP were spiked at the 10.0-ppb level, and 1,2,4,5-TeBB was spiked at 1.0 ppb as a low-level surrogate to check the sensitivity of the method. Since surrogates were spiked into each field and QC sample, a large amount of surrogate recovery data is available.

The MS/MSD QC samples were created for 1 out of every 20 field samples by spiking 5.0 ppb of LCICs into a portion of a field sample. The MS recovery measures the accuracy of the chemical analysis method.

The BQC samples, ranging in LCIC concentrations from 0.2 ppb to 3.0 ppb, were prepared in a soil or sand matrix by EMSL-LV. The participating laboratories extracted one BQC sample with each extraction batch of up to 10 field samples. The BQC samples were single-blind, since the laboratories knew which samples were BQCs but did not know the concentration of LCICs in the BQC samples. The recovery of LCICs from the BQC samples is a measure of method accuracy.

Surrogate Recoveries

Box plots were prepared to illustrate the recoveries achieved by each laboratory for each of the three surrogates. A separate box plot is shown for each surrogate for the field samples and for the QC samples analyzed by each laboratory. An example is shown in Figure I-1 (1,4-DBB surrogate recoveries). The box plots for surrogate recoveries from all laboratories had whiskers that came close to, or went beyond, one or both control limits. Thus, meeting the surrogate recovery criteria was reasonably difficult, and reinjections and re-extractions were needed for surrogate recoveries outside the control limits. When the surrogate recovery was outside the control limit in the same direction for both the original sample and the re-extraction, the laboratory submitted both sets of data to show that there was a consistent problem beyond its control. Such problems tended to happen occasionally when a matrix interference caused a high surrogate recovery.

A summary of surrogate recovery results is shown in Table I-6 for field samples and in Table I-7 for laboratory QC samples. Table I-6 includes surrogate results for 18 duplicate sample analyses, as well as for any sample that required dilution because of high LCIC concentration.

As shown in the tables and box plots, the surrogate recovery tends to be lower than 100 percent because of unavoidable losses from the sample extraction and cleanup. For 1,4-DBB, the mean recoveries ranged from 66 to 87 percent and the median recoveries ranged from 64 to 80 percent. Laboratories 1 and 3 tended to be on the low side, and Laboratories 2 and 8 tended to be on the high side. However, no significant volatility discrimination was observed among the laboratories. That result is contrary to the findings of the pilot study; it indicates that method modifications and additional training in the extraction protocol were successful in producing more uniform extractions among the laboratories.

For 2,4,6-TBBP, the mean and median recoveries ranged from 75 to 104 percent and 70 to 100 percent, respectively. Laboratories 1 and 6 were on the low side, while Laboratories 3 and 7 were on the high side. Laboratories 3 and 7 tended to experience more outliers outside the advisory upper control limit than the other laboratories.

For 1,2,4,5-TeBB, the low-level surrogate, the mean and median recoveries ranged from 71 to 214 percent and 65 to 95 percent, respectively. Laboratory 1 experienced unusually high recoveries of 1,2,4,5-TeBB for one field sample and its re-extraction/reinjection analysis. These high surrogate recoveries, in the range of 2,000 to 10,000 percent, were probably caused by a matrix interference and contributed to a high mean percent recovery. Laboratory 3 again showed high recoveries and tended to be outside the upper limit.

It is interesting to note that all three surrogates tended to have slightly higher recoveries in the QC samples than in the field samples. The effect is most notable for the first surrogate, 1,4-DBB, suggesting that the soil matrix or interferences may cause recoveries to decrease.

MS Recoveries

The MS and MSD recoveries were examined using box plots for each laboratory by LCIC. An example is shown in Figure I-2 (A-BHC matrix spike recoveries). The advisory limits for MS recovery are also shown on the plot. A summary of MS and MSD recoveries is shown in Table I-8. The table contains a count of MS/MSD samples, the mean recovery, the relative standard deviation, the maximum recovery, and the minimum recovery.

The MS recovery bias was comparable from laboratory to laboratory, with medians typically in the range of 60 to 80 percent. There are, however, several notable deviations:

(1) Laboratory 1 had low MS recovery for all LCICs except 2-CNP.

(2) Laboratory 4, for which only one MS/MSD pair was analyzed (because of the sample preparation problems noted in Volume III), also showed this behavior.

(3) All laboratories experienced low recoveries for 2-CNP, with medians in the range of 28 to 60 percent and means in the range of 11 to 56 percent. This tendency toward low recovery for 2-CNP was noted during the method validation, but a complete explanation was never found.

There was good agreement in median and mean MS recovery between the laboratories for all LCICs. Such an agreement indicates that samples were being prepared and analyzed using comparable procedures in all laboratories. The exception is Laboratory 1, which had a slight negative bias relative to the other laboratories for all LCICs except 2-CNP. Laboratory 4 also appeared to have difficulty (low recoveries), but there is not enough information to fully assess this problem.

BQC Sample Recoveries

Box plots and summary tables of percent recovery for EPA BQC samples were examined for each LCIC by laboratory. An example box plot is shown in Figure I-3 (G-BHC BQC recoveries). Table I-9 summarizes the percent recovery of the BQC sample analysis. The mean percent recovery was used to assess bias. The mean percent recoveries ranged from 60 to 89 percent for all LCICs with the exception of 2-CNP, which had mean percent recoveries of 50 percent. The relative standard deviation of BQC recovery ranged from 15 to 72 percent. The percent recovery for each laboratory and LCIC tended to be lower than 100 percent because of the unavoidable losses experienced during sample extraction and cleanup. There were no major differences in bias. Laboratory 2's percent recoveries were biased slightly low for six of eight LCICs and, to a lesser extent, Laboratory 1's recoveries were low for five of eight LCICs. Laboratory 8 showed a slightly high bias for 1,2-dichlorobenzene (1,2-DCB), caused by a small amount of laboratory contamination, as indicated from the method/holding blank results.

Table I-9 also shows that the percent recoveries of the LCIC from sand samples were generally lower than from the soil samples, except for Laboratory 7. This notable effect could be a consequence of differences in the way the sand and soil BQC samples were prepared.

MS/BQC Comparison

An interesting comparison is seen when the MS and BQC recovery results are examined together. An example is shown in Figure I-4 (B-BHC MS and BQC recoveries). No acceptance limits are shown for BQC recovery because these acceptance limits varied with the concentration of the LCICs in the BQC samples. The MS samples were spiked at the 5.0-ppb level, while the BQC concentrations ranged from 0.2 ppb to 3.0 ppb. However, there is a nearly consistent subtle bias between the MS and BQC recoveries. For 1,2-DCB and 1,2,4-trichlorobenzene (TCB), the BQC recoveries tend to be higher than the MS recoveries. For the rest of the LCICs, with the exception of 1,2,4,5-TeCB, the MS recoveries tend to be higher than the BQC recoveries. This minor effect might be explained by the relative volatility of the LCICs and the manner in which these two types of QC samples were prepared. The MS samples were prepared just before extraction, while the BQC samples were prepared in advance and stored before extraction.

Method/Holding Blanks

An MHB sample, consisting of soil that was demonstrated to be uncontaminated with LCICs or LCIC interferences, was extracted with every batch of field samples. The MHB was acceptable if the equivalent concentration of LCIC or LCIC interferences was below 0.5 ppb (0.6 ppb for 1,2-DCB). Because of the inclusion of a blank requirement on LCIC interferences, the acceptance rules for MHBs were involved so that unnecessary re-extractions were minimized. The MHB interpretation rules were slightly subjective, because a visual examination of the selected ion current profile was needed to determine if a potential LCIC interference peak was close enough to the LCIC retention time to affect quantitation.

Table I-10 provides a summary of the MHB results for each LCIC and each laboratory. This summary is based solely on the computerized MHB equivalent concentrations reported by the laboratories and does not include the results of applying the MHB interpretation rules. All MHBs reported in the study were accepted by the EMSL-LV when the SICPs were scrutinized.

The slightly elevated levels of 1,2-DCB, especially notable in Laboratory 8, were caused by minor laboratory contamination. The high concentrations of B-BHC and G-BHC were caused by the ubiquitous interferences arising from the laboratory detergent used to clean glassware. All laboratories experienced this interference to some extent and had to be exceedingly careful to either minimize the concentration of the interference or to chromatograhically separate it from the BHCs.

Field Handling Blanks

A number of double-blind FHBs were analyzed by each laboratory during the study to demonstrate that field samples were not being contaminated with LCICs or LCIC interferences during the sample collection, soil preparation, or chemical analysis processes. Table I-11 summarizes the FHB results and allows a comparison of the FHB results with the MHBs extracted in the same batch. Most LCICs show only a very slight increase in concentration of the FHBs compared to the MHBs. The largest effect is for 1,2-DCB, which increased by an average of 0.1 to 0.2 ppb in all laboratories. All other increases were less than 0.1 ppb.

There are two possible causes for this marginal effect. The first possibility is that there were low levels of LCICs in the FHB matrix. The MHBs were based on a sand matrix carefully prepared and provided by EPA to be used as a method blank material. The FHBs were based on a soil matrix selected to be similar in composition to soil from the Love Canal area. While chemical analysis showed this soil to be acceptable as a blank matrix, there could be low levels of LCICs present. Another possibility is that the slight elevation of FHB concentrations over the MHB concentrations is caused by small amounts of contamination experienced during sample collection, soil preparation, or transportation. This small degree of contamination did not trigger any corrective action during the laboratory phase of the project and is not expected to degrade the usefulness of the results, since the contamination levels observed are less than the precision of the analysis method.

PRECISION

Precision can be assessed using the same three QC measures used to assess accuracy: surrogate recovery, MS recovery, and BQC recovery. Variations of surrogate recovery, MS recovery, and BQC recovery are each measures of precision. This assessment would include sources of variability over the course of the laboratory phase of the project. The intrinsic, within-laboratory precision of the analysis method can be assessed by comparing the MS and MSD recoveries, since these pairs of samples are generally extracted and analyzed at the same time. The MS/MSD precision is usually expressed as an RPD of the paired recoveries. In addition, field split samples have been used to assess interlaboratory precision.

Surrogate Recoveries

The box plots and summary tables of surrogate recoveries described above under Accuracy (Figure I-1 and Tables I-6 and I-7) were also used to qualitatively assess the precision of sample preparation. For 1,4-DBB, the precision of surrogate recoveries was comparable among the laboratories, with Laboratory 1 being slightly less variable and Laboratory 2 slightly more variable. For 2,4,6-TBBP, Laboratory 3 was slightly more variable and Laboratory 6 was slightly less variable than the other laboratories. For 1,2,4,5-TeBB, Laboratory 3 was noticeably more variable than the other laboratories, while Laboratories 2 and 6 were slightly less variable.

MS Recoveries

Using the MS/MSD percent recovery box plots described above under Accuracy (Figure I-2, A-BHC surrogate recoveries), it is possible to assess the sample preparation and analysis precision achieved over the course of the project. There were some notable differences among laboratories in precision. Laboratories 1 and 6 showed better precision than the other laboratories for four to five LCICs. Laboratories 3 and 8 showed poorer precision than the other laboratories for five to seven LCICS.

Within-laboratory precision was assessed using data from the MS/MSD pairs. Table I-12 summarizes the precision results for MS/MSD analyses. The Relative Percent Difference (RPD) between MS and MSD percent recoveries were examined for each LCIC by laboratory, using Table I-12 and box plots. An example of the box plots is shown in Figure I-5 (5a: 2-CNP, 5b: A-BHC MS/MSD RPDs).

The advisory limit for MS/MSD RPD was 30 percent (35 percent for D-BHC). This advisory limit was met for nearly all LCICs by all laboratories except for 2-CNP at most laboratories and B-BHC at Laboratory 8. As shown in Figure I-5 and Table I-12, Laboratories 1 and 6 achieved noticeably lower RPDs than most other laboratories for five or six LCICs. Laboratories 3 and 8 had RPDs that were higher than the other laboratories for five LCICs. Of note were the RPDs for 2-CNP, which were higher in all laboratories except Laboratory 1 than for all other LCICs. As noted above in the Accuracy section, this variability was also accompanied by markedly low recovery. This effect was noted during the method development and validation, but no acceptable explanation has been found.

BQC Sample Recoveries

The variability of percent recovery for BQC samples was examined for each LCIC by laboratory using the box plots (Figure I-3, G-BHC BQC recoveries) and summary table (Table I-9) described above under Accuracy. The Interquartile Range (IQR), which is the height of the box, was used to assess precision. The IQRs varied from a low of about 10 percent to a high of about 50 percent.

Precision, as seen from the IQR, varied somewhat from LCIC to LCIC. Laboratories 2, 6, and 7 showed slightly lower precision for one or two of the eight LCICs. Laboratories 1 and 6 showed high precision for five of the eight LCICs.

As demonstrated in Table I-9, which shows the sand samples separately from the soil samples, the percent Relative Standard Deviation (RSD) for the sand samples was generally lower than for the soil samples. This difference is probably because the sand samples were more homogeneous and had less interferences than the soil samples. The matrix interference in some soil samples also prevented the reliable identification of LCICs, especially for the BHCs. This may be the reason for the zero percent recovery of the BHC compounds.

Field Split Samples

A number of field samples were split in half in the soil preparation laboratory and were sent to two different laboratories. A comparison of the results from these field splits was made to assess the analytical method precision. These results are expressed as RPD between the pairs of results and are presented as box plots in Figure I-6. (Only two field splits were sent to the same laboratory, as discussed in Volume III. These within-laboratory splits are denoted "w" in Figure I-6, while the between-laboratory splits are denoted "b.") Only the results with a detected concentration have been included in Figure I-6. There were actually 62 pairs of between-laboratory split samples, but many of these yielded a non-detect result for one or both halves of the split for the BHCs and 2-CNP. For the non-BHC LCICs, the median RPDs were below 50 percent. For the BHCs, the median RPDs ranged from 40 percent for A-BHC up to 70 percent for D-BHC.

COMPARABILITY

Comparability is only qualitatively defined and assessed in the classical QA/QC approach, but it can be examined more rigorously using chemometrics. These assessments include both intralaboratory and interlaboratory comparability. A lack of comparability means that using these data for purposes that depart from the balanced design of the soil assessment for indicator chemicals could result in erroneous trends or results.

Initial Calibration (IC)

Box plots of the RRFs for each of the five calibration standards from each of the ICs for each LCIC and surrogate standard by laboratory were examined. Figure I-7 (2,4,6-TBBP IC RRFs for Laboratory 3) shows an example. The number of ICs ranged from 3 for Laboratory 8 to 10 for Laboratory 3. Since Laboratory 3 performed a large number of ICs, it appears that there was a problem with maintaining stable instrument performance in that laboratory. There tended not to be a consistent pattern in the RRF values from one IC to the next within the laboratories; this was especially noticeable in Laboratory 3. This indicates that either the instrument sensitivity was not gradually degrading during the course of the study as might be expected, or the instrument operators were compensating for any degradation by changing instrument operating parameters.

The RRFs generally agreed from laboratory to laboratory for each LCIC and surrogate, except for 1,2-DCB at Laboratory 6, which had a noticeably higher Relative Response Factor (RRF) than the other laboratories. In general, Laboratory 6 tended to have tight, precise ICs, with RRFs that varied in magnitude from one IC to another, while Laboratory 8 tended to have a broad range of IC RRFs that did not change much from one IC to another. This suggests that the GC/MS in Laboratory 6 was more linear over the concentration range of the calibration standards while the GC/MS in Laboratory 8, while not quite as linear, was more stable. This conclusion is supported by the observation that Laboratory 8 only needed to perform three ICs over the course of the project.

Performance Check Ion Ratios

The identification of the presence of LCICs in samples is confirmed using the ratio of the secondary to the primary ion area. For a confirmed identification this ratio must be within ± 20 percent of the theoretical ratio. If a laboratory typically gets ion ratios that are different from theory, it may get a higher fraction of false negatives because of failed ion ratios. Non-detects resulting from failed ion ratios can also be caused by chemical interferences. The ion ratios obtained for each performance check chromatogram were examined using box plots. An example is shown in Figure I-8 (2-CNP ion ratios).

All laboratories had good agreement between the first (PC1) and second (PC2) performance check ion ratios. For the non-BHC LCICs, all laboratories were well within the ion ratio control limits, and the ion ratios were comparable from laboratory to laboratory. For the BHCs, ion ratio variability often approached the control limits. There were also notable biases in the ion ratios from laboratory to laboratory.

For 1,2-DCB, all laboratories had comparable ratios except Laboratory 6, which had high outliers. For 1,2,4-TCB, Laboratory 6 was more variable than the other laboratories. For 1,2,3,4-TeCB, Laboratory 3 had notably tight ion ratios. For 2-CNP, Laboratories 2 and 3 were biased slightly high and Laboratory 6 was biased slightly low. For all four BHCs, Laboratories 2 and 8 had more variable ion ratios that approached the upper control limit. Laboratory 3 tended to have less variable ion ratios for the BHCs. For the internal standard D10-pyrene (IS5), the ion ratios were precise and comparable except for Laboratories 2 and 3, which had ratios that were variable and biased high.

Performance Check Sensitivity

During each performance check chromatogram, the sensitivity of the GC/MS is evaluated by measuring the Signal to Noise Ratio (S/N) for the LCIC B-BHC and the surrogate standard 1,2,4,5-TeBB at the 0.5-ppb level. The control limit is that the S/N be above 2.5. These S/Ns were examined using box plots. An example is shown in Figure I-9 (B-BHC S/N).

A low S/N indicates that the instrument is not performing sensitively. In this case, the laboratory may experience false negatives because of inadequate sensitivity. A tight dispersion of S/N indicates good precision and instrument stability.

For B-BHC, the S/N tended to be in the range of 5 to 25. Laboratory 2 tended to have a low but precise S/N of about 5. Laboratory 3 had a high but highly variable S/N from below 2.5 to 90. Typically, the PC2 S/N was slightly lower than that for PC1, indicating that the instrument tended to lose some sensitivity during the analysis shift. For TeBB, the S/Ns were comparable from laboratory to laboratory at about 5 to 10, with two exceptions: Laboratory 8 had a higher S/N of about 10 to 20, and Laboratory 3 had a highly variable S/N from below 2.5 to about 65.

Performance Check Resolution

Chromatographic efficiency had to be demonstrated at the beginning and the end of each analysis shift. This was determined using the resolution between 1-chloronaphthalene (CNP) and the LCIC 2-CNP for both the PC1 and PC2 and between B-BHC and G-BHC in PC2. The resolution is expressed as the fractional height of the valley between the two peaks relative to the average height of the two peaks. This is referred to as the percent valley (%V). Chromatographic resolution was examined using box plots. An example is shown in Figure I-10 (2-CNP PC1%V).

Laboratories 3 and 7 had small, precise %Vs, indicating excellent resolution and good chromatographic stability. The %V for Laboratories 1, 6, and 8 was larger and more variable, indicating less ideal chromatographic performance. None of the laboratories had difficulty meeting the %V control limit. For BHC resolution, Laboratories 3 and 7 continued to have excellent and precise resolution. Laboratories 1 and 8 had some outliers that approached the %V control limit.

Continuing Calibration (CC) Relative Response Factors

In the CC chromatogram at the beginning of each analysis shift, the RRF for each LCIC and surrogate is determined and compared to the mean RRF obtained from the most recent initial calibration. Calibration stability and comparability were examined using box plots of the percent difference between the CC and IC RRFs for each laboratory by LCIC and surrogate. An example is shown in Figure I-11 (B-BHC: CC RRF).

While there were some notable differences in precision, there was not a consistent pattern from one LCIC to another. It seems that some laboratories were able to hold a stable calibration for one LCIC and other laboratories for another LCIC. The precision for the non-BHC LCICs appears to be more stable than for the BHCs and the surrogates. This might mean that compounds eluting early in the chromatogram are quantitated more reliably than those eluting later.

IS Area Variation

Box plots of the percent difference between the IS area for each field and QC sample and the corresponding CC standard were examined for each laboratory. An example is shown in

Figure I-12 (IS4 area percent difference). The horizonal lines indicate the control limits for this parameter.

Generally, the performance for all five ISs was comparable among all laboratories. In many cases the box plot whiskers came close to, or extended beyond, the control limits. This indicates that the laboratories experienced some difficulty in staying within the limits. There were only slight biases between field and QC samples within a laboratory. These biases were not consistent from laboratory to laboratory. In general, Laboratories 1 and 6 tended to be slightly more precise, while Laboratories 2 and 7 tended to be slightly more variable.

IS Raw Area Trends

Trend plots of raw IS areas versus the date of analysis were examined for each of the five ISs to assess the long-term stability of the operation of the GC/MS instrument in each laboratory. An example is shown in Figure I-13 (IS area trend for Laboratory 1). For this and the remaining trend plots, vertical lines indicate the dates of initial calibration.

The typical behavior for the IS areas is to decrease gradually over time as the instrument is used, suggesting that the sensitivity of the analysis is gradually decreasing. Such a downward trend was seen in Laboratories 2 and 8. Other laboratories tended to show this trend over shorter periods of time, with some discontinuities, after which noticeably higher IS areas were seen. These breaks in the trend are probably caused by cleaning the MS source or quadrupoles, by replacing the GC column or injection port liner, or by increasing the MS accelerating voltage or detector gain. Abrupt changes in IS area are generally synchronized with new ICs. An upward trend could be caused by an increase in the concentration of the IS spiking solution due to evaporation of the solvent.

IS Retention Time (RT) Trends

Long-term stability of the GC/MS was also examined using trend plots of IS RT versus the analysis date. An example is shown in Figure I-14 (IS5 RT trend for Laboratory 1). Typical behavior is a gradual decrease in RT as the GC column stationary phase is degraded or compromised by the field sample extract matrix or as short pieces of the front end of the fused-silica GC column are cut off to maintain acceptable GC performance. Such a trend is seen in Laboratory 8. Discontinuities in IS RT can be caused, for example, by replacing the GC column, changing the GC temperature program, or by changing the carrier gas flow rate. Such behavior of stability, punctuated by breaks in the IS RT, were seen at Laboratories 1, 2, and 7. Laboratory 6 displayed a less obvious trend, with IS RTs changing over a smaller range than changes at other laboratories. Laboratory 3 had a gradual upward trend with one upward discontinuity, indicating that perhaps the carrier gas flow rate was decreasing.

CC RRF Trends

Ideally, the RRFs should display no discernible trends over the course of the study. Any change in the response of the instrument to an LCIC should be reflected by a corresponding change in the response to the associated IS, keeping the RRF constant. Continuing calibration RRF stability was examined by preparing time series plots for each LCIC and each laboratory. An example is shown in Figure I-15 (CC RRF trend for Laboratory 6). The trends themselves were well-behaved, either gradually increasing, decreasing, or staying essentially flat. The pattern of trends for each LCIC across laboratories or for each laboratory across LCICs was, however, complex. Each laboratory displayed a combination of trends that differed from every other laboratory. This suggests that the relative sensitivity of the GC/MS instruments to LCICs and ISs was changing independently in each laboratory. Presumably, the CC performed at the beginning of each analysis shift correctly determined these relative sensitivity changes, resulting in accurate quantitation. Since the laboratories passed the criteria for every EPA check standard for calibration accuracy, it appears that there was accurate quantitation, thus demonstrating the importance of CC.

Surrogate Recovery Trends

Surrogate standards are spiked into each sample prior to extraction. Surrogate recoveries are used as a QA/QC measure to demonstrate that sample extraction and cleanup have been efficiently performed. Low surrogate recovery is taken as an indication that the laboratory has failed to successfully prepare samples. Excessively high surrogate recovery can be caused by matrix interferences. Trend plots of surrogate recovery versus date of analysis were examined to assess the long-term stability of the sample preparation process. An example is shown in Figure I-16 (1,2,4,5-TeBB surrogate recovery for Laboratory 8).

For most laboratories, only random variation was seen. Only very slight upward or downward trends were discernible, indicating that the sample preparation process was being employed consistently over the course of the project. Laboratories 3 and 4 exhibited a higher degree of variability or more frequent outliers, indicating a lower level of diligence at those laboratories. Laboratory 7 had a higher degree of variability at the beginning of the study, showing some difficulties in initiating the project. Laboratory 8 showed the opposite trend, indicating that sample preparation diligence degraded near the end of the project.

SUMMARY

A summary assessment of chemical data quality for this project is difficult because of the wide range of performance indicators examined. Certainly, no major defects in data quality were found, and the notable observations presented in this appendix are predominantly subtle differences in laboratory performance.

Laboratory 6 had the most consistent performance, as evidenced by high accuracy and precision. Laboratory 1 had high precision but was biased slightly low relative to the other laboratories. Laboratory 3 displayed consistent evidence of increased variability relative to the other laboratories.

Quantitation of 2-CNP appears to be less stable and biased lower than the other LCICs. While this difficulty is not expected to seriously affect the statistical comparisons for habitability, alternative uses of the 2-CNP results should be made with caution.

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REFERENCES

CH2M HILL 1986. Pilot Study for Love Canal EDA Habitability Study. (Vol. I and II.)

CH2M HILL 1987a. Love Canal Habitability Study--Soil Sample Collection and Preparation Quality Assurance Project Plan.

CH2M HILL. 1987b. Love Canal Habitability Study--Soil Sample Analysis Quality Assurance Project Plan.

Delaney, M.F. 1984. "Chemometrics." Analytical Chemistry, 56-261R-277R.

Massart, D.L., Vandeginste, B.G.M., Deming, S. N., Michotte, Y., and Kaufman, L. 1988. Chemometrics: A Textbook. Elsvier Science Publishing Company, Inc. Amsterdam.

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Table I-1
NUMBER OF FIELD SAMPLES RECEIVED AND ANALYZED BY LABORATORY

Analytical Laboratory[a]	No. of Samples Planned	No. of Samples Received	No. of Samples Analyzed
1	122	119	119 + 38[b]
2	125	121	121
3	128	125	124[c]
4	135	135	0[d]
6	137	133	133
7	110	109	109
8	137	137	137
TOTAL	894	879	781

---

[a] Laboratory 5 was not selected for study participation.

[b] Thirty-eight samples extracted by Laboratory 4 were sent to Laboratory 1 for analysis.

[c] One sample was not analyzed.

[d] Laboratory 4 did not successfully analyze any samples.

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Table I-2
SUMMARY OF FIELD SAMPLES ANALYZED BY LABORATORY AND SAMPLE TYPE

Type of Samples	Laboratory[a]						
	1	2	3	6	7	8	Total
Field Samples	119 + 38[b]	121	124	133	109	137	781
Field Handling Blank	14 + 3[c]	12	11	10	6	11	67
Field Split	22 + 1[d]	17	14	9	4	6	73[e]
Total	197	150	149	152	119	154	921

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[a] Laboratory 4 did not participate in the sample analysis.

[b] Thirty-eight samples extracted by Laboratory 4 were sent to Laboratory 1 for analysis.

[c] Three of Laboratory 4's FHB were analyzed by Laboratory 1.

[d] One field split from Laboratory 4 was analyzed by Laboratory 1.

[e] Valid results were obtained for both halves in 64 field split pairs.

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Table I-3
SUMMARY OF PERCENTAGE OF GOOD, UNCERTAIN, AND BAD FLAGS[a]

Analytical Laboratory	% of Results Designated As Good	% of Results Designated As Uncertain	% of Results Designated As Bad
1[b]	84.6	2.4	12.9
2	83.7	4.1	12.2
3	84.3	12.6	3.1
6	94.4	4.7	0.1
7	94.3	3.4	2.3
8	72.4	18.3	9.2
TOTAL	85.7	7.6	6.6

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[a] Table represents counts of flags associated with the 781 field samples used in the statistical comparisons.

[b] Include samples originally sent to and extracted by Laboratory 4 but analyzed by Laboratory 1.

Table I-4
SUMMARY OF LABORATORY QC SAMPLES ANALYZED BY LABORATORY AND SAMPLE TYPE

Type of QC Samples	Laboratory[a]						
	1	2	3	6	7	8	TOTAL
Method/Holding Blanks	47[b]	19	34	28	20	28	176
Blind QC Samples	43[c]	46	33	29	21	27	199
MS/MSD	20[d]	23	23	24	16	16	122[e]
EPA Check	7	8	17	8	5	8	53
TOTAL	117	96	107	89	62	79	550

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[a] Laboratory 4 did not participate in the sample analysis.

[b] Eight of Laboratory 4's MHBs were analyzed by Laboratory 1.

[c] Six of Laboratory 4's BQCs were analyzed by Laboratory 1.

[d] Two of Laboratory 4's MS/MSDs were analyzed by Laboratory 1.

[e] Duplicate analyses were included where reported by the laboratory.

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Table I-5
QC DATA SUMMARY

			Data Meeting QC Criteria	
QA Measure	Compounds	Laboratory	Goal (%)	Achieved (%)
Method Holding Blank	All LCICs	1	90	99.7
		2		99.1
		3		99.1
		6		98.7
		7		100
		8		92.4
Surrogate Spike Recovery	1,4-DBB 2,4,6-TBBP and 1,2,3,4-TeBB	1	90	96.1
		2		98.7
		3		97.4
		6		98.9
		7		95.5
		8		97.3
Matrix Spike Recovery (Advisory only)	All LCICs	1	90	65.6
		2		84.7
		3		80.6
		6		88.0
		7		80.4
		8		83.9
Matrix Spike Duplicate Precision (Advisory only)	All LCICs	1	90	96.3
		2		94.3
		3		83.3
		6		95.8
		7		89.3
		8		87.5
Initial Calibration Standard	All LCICs plus 1,4-DBB, 2,4,6-TBBP, & 1,2,4,5-TeBB	1	100	100
		2		100
		3		100
		6		100
		7		100
		8		100
EPA Check Standard Recovery	All LCICs plus 1,4-DBB, 2,4,6-TBBP, & 1,2,4,5-TeBB	1	100	100
		2		100
		3		100
		6		100
		7		100
		8		100
Performance Check Standard	All LCICs plus d_{10}-pyrene, 1-CNP and 1,2,4,5-TeBB	1	100	100
		2		100
		3		100
		6		100
		7		100
		8		100
Continuing Calibration Standard	All LCICs plus 1,4-DBB, 2,4,6-TBBP, 1,2,4,5-TeBB	1	100	100
		2		99.5
		3		100
		6		100
		7		100
		8		99.7
Internal Standard Area Variation	d_4-1,4-DCB d_8-Naphthalene d_{10}-acenaphthene d_{10}-phenanthrene d_{10}-pyrene	1	90	99.9
		2		98.4
		3		99.3
		6		99.0
		7		94.8
		8		98.5

Table I-5
(continued)

QA Measure	Compounds	Laboratory	Data Meeting QC Criteria Goal (%)	Data Meeting QC Criteria Achieved (%)
BOC Recovery	All LCICs	1	90	93.0
		2		90.8
		3		92.1
		6		94.8
		7		95.8
		8		90.3

Note: In this table all results for both field and QC samples of all data usabilities (G, U, and B) have been included.

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Table I-6
SUMMARY STATISTICS OF SURROGATE ANALYSIS RESULTS
(HS SAMPLES ONLY)

Analyte	Lab	Count	Mean % Recovery	Std. Dev. % Recovery	% RSD	Minimum % Recovery	Maximum % Recovery
1,4-DBB	1	121	67.7	7.3	10.7	49.8	83.1
	2	121	80.8	10.6	13.1	51.5	104
	3	128	65.8	9.5	14.4	50.2	111
	4	40	66.2	13.1	19.8	33.5	85.0
	6	137	70.9	9.2	12.9	42.2	90.4
	7	113	76.3	10.9	14.3	47.4	102
	8	139	81.8	11.9	14.5	36.0	103
	TOTAL	799*	73.5	11.9	16.2	33.5	111
			Median 73.0				
2,4,6-TBBP	1	121	74.5	10.9	14.6	56.1	134
	2	121	94.4	15.8	16.7	59.3	148
	3	128	94.8	18.4	19.4	57.5	175
	4	40	73.0	15.1	20.6	32.4	97.6
	6	137	85.8	11.5	13.4	58.5	129
	7	113	102	16.5	16.2	66.4	168
	8	139	89.8	15.6	17.4	38.8	154
	TOTAL	799*	89.1	17.4	19.5	32.4	175
			Median 88.1				
1245-TeBB	1	121	214	982	458	28.1	10025
	2	121	86.9	11.6	13.3	53.2	114
	3	128	88.3	22.3	25.2	0.0	211
	4	40	66.9	19.6	29.3	16.0	127
	6	137	74.9	14.3	19.1	0.0	126
	7	113	82.4	17.5	21.3	0.0	113
	8	139	83.3	16.7	20.1	44.7	144
	TOTAL	799*	102	384	376	0.0	10025
			Median 79.6				

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*Results from 18 duplicate samples' analyses were included.

Table I-7
SUMMARY STATISTICS OF SURROGATE ANALYSIS RESULTS
(Laboratory QC Samples Only)[a]

Analyte	Lab	Count	Mean % Recovery	Std. Dev. % Recovery	% RSD	Minimum % Recovery	Maximum % Recovery
1,4-DBB	1	110	75.8	8.6	11.3	34.9	90.1
	2	88	87.1	9.1	10.4	68.7	111.0
	3	90	74.1	10.3	13.9	51.0	110.0
	6	81	78.2	7.5	9.7	57.5	96.3
	7	57	83.3	15.2	18.2	46.1	108.0
	8	71	85.4	12.6	14.7	58.8	122.0
	TOTAL	497	80.2	11.5	14.4	34.9	122.0
2,4,6-TBBP	1	110	77.4	10.9	14.2	35.5	101.0
	2	88	96.8	15.0	15.5	66.2	139.0
	3	90	95.1	14.1	14.8	61.3	151.0
	6	81	87.3	12.2	14.0	59.9	121.0
	7	57	104.0	18.3	17.5	57.8	138.0
	8	71	91.9	15.0	16.4	58.8	121.0
	TOTAL	497	90.8	16.4	18.0	35.5	151.0
1,2,4,5-TeBB	1	110	70.8	10.1	14.3	28.1	94.4
	2	88	86.3	12.4	14.3	57.9	114.0
	3	90	94.4	31.6	33.5	66.0	325.0
	6	81	81.2	15.4	19.0	58.2	188.0
	7	57	90.0	17.2	19.1	57.6	113.0
	8	71	87.0	13.6	15.6	56.1	111.0
	TOTAL	497	84.1	19.8	23.5	28.1	325.0

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[a] Table includes surrogate results for Method Blanks, Matrix Spike, and Matric Spike Duplicate analyses and EPA Blind QC analyses.

Table I-8
SUMMARY STATISTICS OF MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RECOVERY RESULTS

Compound	Lab[a]	Count[b]	Mean (% Rec) MS	Mean (% Rec) MSD	% RSD (% Rec) MS	% RSD (% Rec) MSD	Maximum (% Rec) MS	Maximum (% Rec) MSD	Minimum (% Rec) MS	Minimum (% Rec) MSD
1,2-DCB	1	10	53.7	53.2	11.8	11.7	63.9	62.5	44.4	44.2
	2	11	79.2	79.9	11.6	12.7	99.6	94.0	65.2	64.1
	3	8	67.2	64.5	25.5	33.2	96.6	96.5	44.9	23.2
	6	12	69.4	67.1	13.8	14.5	88.5	79.1	49.6	47.5
	7	7	73.1	70.9	5.9	14.7	79.5	82.1	64.9	51.2
	8	7	68.4	62.3	19.3	20.2	80.0	84.3	46.4	50.8
1,2,4-TCB	1	10	59.1	61.6	12.4	11.6	73.1	73.2	52.4	51.7
	2	11	80.1	79.9	13.3	10.0	99.6	95.8	61.6	69.5
	3	8	77.0	69.1	31.6	39.5	103.5	92.8	30.2	15.4
	6	12	73.6	71.3	12.8	14.1	88.4	88.5	52.7	53.4
	7	7	70.8	73.7	16.9	19.5	90.1	93.1	57.2	50.8
	8	7	74.2	69.8	13.4	14.2	85.9	86.1	55.7	56.3
1,2,3,4-TeCB	1	10	64.0	67.5	15.3	11.8	82.9	83.1	49.4	55.4
	2	11	82.2	82.3	11.4	11.8	101.8	104.2	70.5	73.4
	3	8	83.7	77.0	16.1	36.5	105.8	99.3	61.7	11.5
	6	12	77.1	74.4	11.0	11.0	87.6	87.8	58.6	61.9
	7	7	75.8	79.8	13.0	14.0	89.3	89.8	63.4	59.0
	8	7	77.4	75.0	15.2	19.7	91.1	98.7	56.2	59.7
2-CNP	1	10	55.2	53.9	16.2	15.5	66.8	69.0	44.1	43.8
	2	11	55.6	54.3	39.6	24.0	93.1	69.3	8.5	26.5
	3	8	50.0	44.1	34.4	40.4	67.8	65.2	12.1	12.0
	6	12	37.4	40.4	53.3	47.2	62.4	65.3	2.0	1.5
	7	7	37.4	33.0	60.9	66.3	80.3	74.0	7.6	11.0
	8	7	47.4	47.2	32.3	28.0	60.1	72.5	22.3	33.4
A-BHC	1	10	63.1	63.7	17.5	14.8	83.3	81.7	45.9	52.0
	2	11	81.5	79.1	15.9	14.6	107.7	95.9	62.0	61.3
	3	8	77.8	74.9	52.0	60.5	108.8	113.1	-14.3	-15.6
	6	12	79.9	79.1	14.1	13.7	100.0	97.8	56.5	58.5
	7	7	76.9	74.8	12.3	14.9	89.5	87.6	64.6	61.7
	8	7	89.0	82.6	19.5	18.5	108.2	103.3	58.7	65.1
D-BHC	1	10	59.4	62.1	18.4	19.7	74.2	82.4	36.4	39.2
	2	11	67.3	69.8	24.0	30.7	88.4	105.1	39.3	36.4
	3	8	57.2	59.8	90.5	93.7	94.0	107.0	-61.1	-61.4
	6	12	81.8	82.3	17.7	15.5	115.7	104.8	66.7	64.7
	7	7	72.9	70.3	15.1	17.9	84.0	83.7	57.9	47.0
	8	7	70.7	64.3	28.6	28.9	100.4	90.9	40.1	44.2
B-BHC	1	10	57.6	61.1	16.4	15.4	74.5	78.4	42.9	47.7
	2	11	67.3	67.3	24.8	31.8	91.5	99.2	33.4	26.7
	3	8	63.2	62.8	94.7	107.0	104.8	111.4	-76.7	-87.6
	6	12	77.3	79.3	26.0	25.2	106.6	99.2	31.1	35.1
	7	7	78.3	75.4	15.3	15.1	91.3	87.8	60.1	56.3
	8	7	81.1	77.7	28.6	23.1	111.3	104.7	40.6	60.2
G-BHC	1	10	63.4	64.8	17.7	15.7	87.0	87.3	49.2	54.7
	2	11	83.2	80.3	15.6	18.7	106.6	102.7	65.8	59.4
	3	8	94.2	92.7	19.6	31.9	112.6	119.7	71.7	36.6
	6	12	85.8	85.8	18.6	16.5	123.9	112.3	65.5	68.6
	7	7	85.0	87.3	12.8	20.5	99.3	114.7	72.4	65.5
	8	7	90.1	82.9	19.8	16.6	115.2	101.1	64.4	64.3

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[a] Laboratory 1 performed one MS/MSD set of analyses on one field sample originally sent to Laboratory 4.

[b] Count of MS/MSD pairs for which all these sample results (native sample, MS, and MSD) were reported.

Table I-9
SUMMARY OF EPA BLIND QC SAMPLE RESULTS

		Count		Mean (% Rec)		% RSD (% Rec)		Maximum (% Rec)		Minimum (% Rec)	
	Lab	Sand	Soil	Sand	Soil	Sand	Soil	Sand	Soil	Sand	Soil
1,2-DCB	1	7	36	61.4	88.3	39.6	47.0	103	230	24.2	31.5
	2	8	38	62.2	85.3	16.8	38.7	78.3	230	50.0	55.8
	3	10	23	68.4	82.1	23.3	44.8	100	218	44.4	25.5
	6	7	22	78.8	87.6	24.3	37.6	110	187	46.7	52.8
	7	3	18	93.9	83.8	4.4	34.2	98.3	155	90	49
	8	6	21	107	119	32.4	58.0	160	380	64.2	56.7
1,2,4-TCB	1	7	36	47.8	72.5	32.0	21.6	68.1	120	26.7	48.5
	2	8	38	46.0	76.5	19.5	17.8	59.3	110	35.6	52.2
	3	10	23	69.2	101.3	24.0	54.6	84.4	330	38.5	54.4
	6	7	22	75.8	89.0	19.8	19.0	102	127	53.3	62.2
	7	3	18	82.9	76.3	3.1	20.6	84.4	115	80	50
	8	6	21	76.7	81.4	23.2	23.6	107	145	83.3	53.3
1,2,3,4-TeCB	1	7	36	44.0	61.0	29.6	14.9	68.0	85	26.0	43.5
	2	8	38	36.1	64.8	25.8	14.9	50.7	92	24.0	46
	3	10	23	61.9	90.5	23.3	58.8	76	329	39.3	54
	6	7	22	72.0	82.3	17.3	12.4	88	105	50.5	64.7
	7	3	18	87.0	69.4	4.1	15.2	90	90	83	53.5
	8	6	21	71.1	67.2	26.4	17.6	102	92	53.5	46
2-CNP	1	7	36	54.1	53.6	33.2	28.6	82.5	95	31.7	37.5
	2	8	38	34.1	49.7	12.7	18.0	42.5	70	30.0	30
	3	10	23	55.8	46.4	21.5	40.1	72.5	110	35.8	0
	6	7	22	71.9	53.2	22.4	26.4	97.5	87.5	46.9	17.5
	7	3	18	80.4	51.0	7.6	26.2	87.5	76	76.3	32.5
	8	6	21	70.2	43.5	31.6	41.9	110	75	46.9	11.7
A-BHC	1	7	36	52.1	60.2	32.1	14.1	76.2	77.1	37.1	42.0
	2	8	38	34.7	61.2	22.3	16.5	46.4	86	22.9	40.7
	3	10	23	63.7	80.9	25.3	41.1	83.6	225	41.4	58.5
	6	7	22	69.5	77.9	17.6	14.0	87.1	113	48.6	60
	7	3	18	85.6	60.4	13.7	18.4	97.1	88.6	73.6	48.9
	8	6	21	66.6	68.9	23.6	32.6	85.7	100	48.9	0.0
D-BHC	1	7	36	49.1	47.4	37.0	26.7	77.8	68.3	32.8	0.0
	2	8	38	29.2	49.9	12.8	23.6	34.4	81.7	25	30
	3	10	23	56.4	76.0	25.1	53.9	83.3	199	36.7	0.0
	6	7	22	70.1	76.3	18.4	28.7	86.7	122	47.5	0.0
	7	3	18	74.5	53.6	3.7	31.9	77.2	81.7	71.7	0.0
	8	6	21	51.3	66.8	46.7	23.2	96.7	103	34.4	38
B-BHC	1	7	36	56.4	53.4	32.5	24.1	84.9	72.0	39.6	0.0
	2	8	38	41.2	57.8	30.7	23.5	56	94	25.3	34
	3	10	23	71.7	73.4	26.1	41.5	94.7	181	44.9	0.0
	6	7	22	72.9	52.2	16.7	65.8	88	100	51.7	0.0
	7	3	18	96.4	54.2	3.6	57.8	100	93.3	93	0.0
	8	6	21	73.5	48.6	29.5	82.6	111	97.8	49.7	0.0
G-BHC	1	7	36	51.8	57.0	30.5	17.6	75.4	83.1	35.4	37.5
	2	8	38	41.0	60.7	20.0	18.8	52.3	98	29.2	36.2
	3	10	23	61.9	78.5	46.1	56.9	97.7	245	0.0	0.0
	6	7	22	71.5	80.0	13.8	27.4	81.5	119	53.8	0.0
	7	3	18	96.5	65.6	3.1	16.6	99.2	83.8	93.3	49.2
	8	6	21	69.5	71.3	25.6	32.2	95.4	102	49.2	0.0

Table I-10
SUMMARY OF LABORATORY METHOD HOLDING BLANK RESULTS[a]

Compound	Lab	Count[b]	No. of Count Exceeded Control Limits	Mean Conc. (ppb)	Maximum Conc. (ppb)	Minimum Conc. (ppb)
1,2-DCB	1	47	0	0.26	0.48	0.05
	2	19	0	0.22	0.38	0.11
	3	34	0	0.15	0.26	0.08
	6	28	0	0.20	0.38	0.084
	7	20	0	0.17	0.45	0.085
	8	28	1	0.49	0.73	0.30
1,2,4-TCB	1	47	0	0.048	0.19	0.019
	2	19	0	0.074	0.21	0.040
	3	34	0	0.041	0.086	0.021
	6	28	0	0.053	0.092	0.024
	7	20	0	0.052	0.14	0.019
	8	28	0	0.065	0.097	0.038
1,2,3,4-TeCB	1	47	0	0.005	0.025	0.001
	2	19	0	0.010	0.022	0.002
	3	5	0	0.004	0.005	0.001
	6	28	0	0.001	0.005	0.001
	7	3	0	0.086	0.15	0.011
	8	28	0	0.005	0.011	0.001
2-CNP	1	47	0	0.067	0.14	0.023
	2	19	0	0.053	0.076	0.027
	3	32	0	0.051	0.47	0.017
	6	28	0	0.056	0.076	0.044
	7	20	0	0.063	0.12	0.020
	8	28	0	0.070	0.17	0.022
A-BHC	1	47	0	0.019	0.10	0.001
	2	19	0	0.020	0.066	0.006
	3	32	0	0.011	0.096	0.001
	6	10	0	0.055	0.080	0.019
	7	20	0	0.029	0.10	0.003
	8	28	0	0.038	0.015	0.005
D-BHC	1	47	0	0.010	0.093	0.001
	2	19	0	0.034	0.070	0.005
	3	30	0	0.021	0.11	0.001
	6	4	0	0.023	0.040	0.016
	7	8	0	0.011	0.030	0.003
	8	28	0	0.040	0.14	0.007
B-BHC	1	47	1	0.13	4.96	0.001
	2	19	2	0.036	0.28	0.007
	3	32	1	0.073	0.51	0.001
	6	25	3	0.39	2.57	0.085
	7	19	0	0.25	0.45	0.114
	8	28	6	0.43	3.54	0.014

Table I-10
(continued)

Compound	Lab	Count[b]	No. of Count Exceeded Control Limits	Mean Conc. (ppb)	Maximum Conc. (ppb)	Minimum Conc. (ppb)
G-BHC	1	47	0	0.022	0.16	0.001
	2	19	0	0.021	0.039	0.008
	3	32	2	0.071	0.65	0.001
	6	0	0	--	--	--
	7	11	0	0.033	0.16	0.004
	8	28	7	0.62	2.61	0.005

---

[a] Table includes results for primary ion concentrations only.

[b] Only detects are included in the counts and statistics.

WDR357/072

Table I-11
SUMMARY RESULTS OF FIELD HANDLING BLANK AND LABORATORY METHOD HOLDING BLANK RESULTS FROM THE SAME EXTRACTON BATCH

			Number Detected		Mean Conc (ppb)		Maximum Conc (ppb)		Minimum Conc (ppb)	
Compound[a]	Lab	Count	MHB	FHB	MHB	FHB	MHB	FHB	MHB	FHB
1,2-DCB	1	14	14	14	0.30	0.41	0.46	0.55	0.21	0.26
	2	12	12	12	0.23	0.39	0.38	0.62	0.11	0.22
	3	11	10	11	0.13	0.25	0.20	0.30	0.10	0.21
	4	3	3	3	0.10	0.28	0.15	0.29	0.05	0.27
	6	10	10	10	0.20	0.26	0.37	0.42	0.13	0.17
	7	7	7	7	0.16	0.28	0.25	0.43	0.09	0.13
	8	11	8	11	0.52	0.76	0.73	1.12	0.30	0.59
1,2,4-TCB	1	14	14	14	0.05	0.10	0.05	0.39	0.04	0.07
	2	12	10	11	0.07	0.11	0.20	0.18	0.04	0.08
	3	11	10	10	0.04	0.12	0.09	0.19	0.02	0.06
	4	3	3	3	0.03	0.09	0.04	0.11	0.02	0.08
	6	10	10	9	0.05	0.09	0.06	0.16	0.04	0.06
	7	7	7	6	0.04	0.13	0.09	0.16	0.02	0.07
	8	11	8	11	0.06	0.15	0.08	0.31	0.04	0.09
1,2,3,4-TeCB	1	14	0	4	--	0.09	--	0.31	--	0.01
	2	12	1	8	0.01	0.03	0.01	0.12	0.01	0.01
	3	11	0	3	--	0.02	--	0.02	--	0.01
	6	10	0	1	--	0.01	--	0.01	--	0.01
	7	7	1	2	0.15	0.04	0.15	0.05	0.15	0.04
	8	11	0	2	--	0.01	--	0.01	--	0.01
2-CNP	1	14	14	14	0.08	0.09	0.10	0.14	0.05	0.06
	2	12	9	6	0.05	0.08	0.07	0.09	0.03	0.07
	3	11	4	3	0.03	0.05	0.04	0.08	0.02	0.02
	4	3	3	3	0.03	0.09	0.05	0.11	0.02	0.07
	6	10	10	9	0.05	0.04	0.08	0.06	0.04	0.03
	7	7	5	6	0.06	0.11	0.10	0.15	0.04	0.03
	8	11	5	6	0.09	0.10	0.10	0.14	0.07	0.07
a-BHC	1	17	0	2	--	0.06	--	0.12	--	0.01
	2	12	0	2	--	0.01	--	0.02	--	0.01
	7	7	1	0	0.10	--	0.10	--	0.10	--
b-BHC	1	17	0	1	--	2.16	--	2.16	--	2.16
	3	11	1	0	0.36	--	0.36	--	0.36	--
g-BHC	2	12	1	0	0.03	--	0.03	--	0.03	--
	7	7	1	0	0.16	--	0.16	--	0.16	--

---

[a] Delta-BHC had no detects.

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Table I-12
SUMMARY OF MATRIX SPIKE AND MATRIX SPIKE DUPLICATE PRECISION RESULTS

Compound	Lab[a]	Count[b]	Mean % RPD	Std. Dev. % RPD	Max. % RPD	Min. % RPD
1,2-DCB	1	10	4.57	4.22	12.5	0.12
	2	11	7.91	5.65	17.6	1.34
	3	8	14.8	23.3	70.6	0.16
	6	12	5.63	7.74	27.6	0.58
	7	7	12.1	12.2	36.8	1.78
	8	7	11.8	9.88	29.9	0.36
1,2,4-TCB	1	10	7.65	9.58	32.5	1.03
	2	11	7.48	6.49	18.4	0.04
	3	8	22.9	37.8	114	1.59
	6	12	6.96	6.59	24.7	1.94
	7	7	11.5	15.9	46.2	0.47
	8	7	6.99	8.08	21.8	0.24
1,2,3,4-TeCB	1	10	8.62	12.9	37.2	0.18
	2	11	8.01	6.42	21.7	0.66
	3	8	22.1	49.3	144	1.42
	6	12	8.46	9.27	32.8	0.86
	7	7	8.36	11.1	32.0	1.42
	8	7	8.47	6.73	23.4	3.40
2-CNP	1	10	6.03	6.09	18.2	1.10
	2	11	28.5	39.0	130	0.57
	3	8	49.6	47.8	122	4.81
	6	12	23.4	26.5	80.8	0.63
	7	7	24.4	29.2	81.9	3.23
	8	7	24.2	18.8	56.9	3.85
A-BHC	1	10	4.79	3.52	12.4	1.44
	2	11	8.74	5.61	23.2	2.31
	3	8	18.4	25.7	80.6	3.87
	6	12	3.99	2.40	7.88	0.23
	7	7	4.82	4.68	12.6	0.23
	8	7	11.0	7.76	24.8	1.15
D-BHC	1	10	7.76	7.33	25.4	0.32
	2	11	15.7	15.5	57.8	1.23
	3	8	23.1	20.8	64.2	0.48
	6	12	7.35	4.76	17.8	0.73
	7	7	11.8	9.69	29.2	0.17
	8	7	19.2	11.7	39.7	5.41

Table I-12
(continued)

Compound	Lab[a]	Count[b]	Mean % RPD	Std. Dev. % RPD	Max. % RPD	Min. % RPD
B-BHC	1	10	9.72	10.5	36.1	0.57
	2	8	17.8	14.8	55.1	1.66
	3	11	18.5	20.4	64.8	2.16
	6	12	7.89	3.95	14.2	0.85
	7	7	6.98	5.16	16.6	0.95
	8	7	26.9	15.3	46.8	10.6
G-BHC	1	10	4.03	4.35	12.8	0.23
	2	11	9.22	4.99	17.3	1.34
	3	8	19.4	19.5	64.8	5.74
	6	12	6.03	5.68	18.4	0.70
	7	7	6.75	6.58	19.3	0.16
	8	7	13.8	9.30	26.1	2.17

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[a] Laboratory 1 performed one MS/MSD set of analyses on one field sample originally scheduled for Laboratory 4.

[b] Count of MS/MSD pairs for which all three sample results (native sample, MS, and MSD) were reported.

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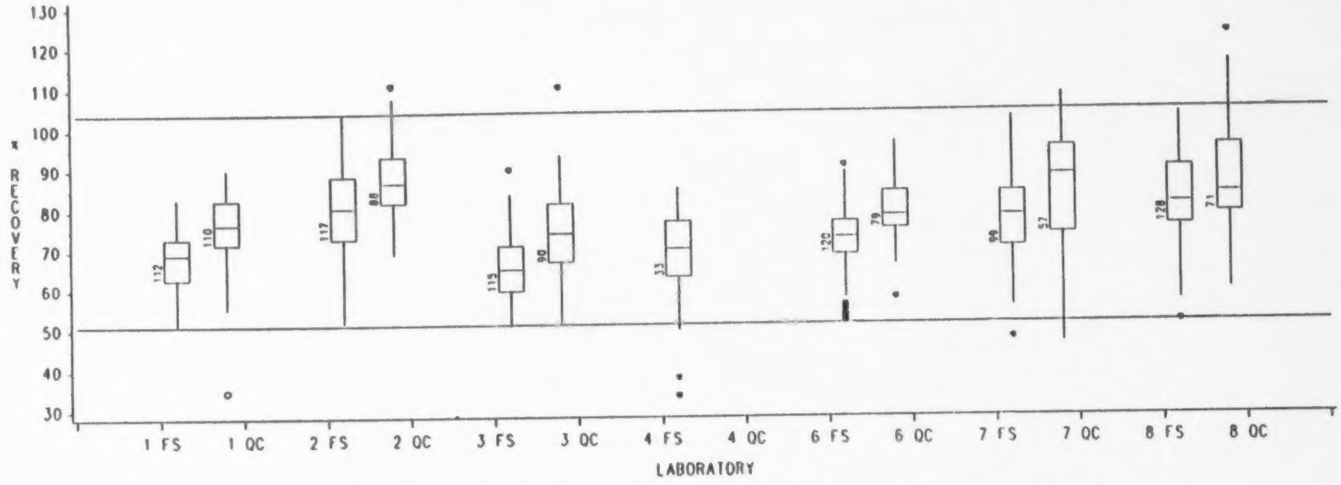


Note: Analytical Results for Samples With Dilution Factor > 1 and for Instrument Blanks are not Included

Figure I - 1
SOIL ASSESSMENT--
INDICATOR CHEMICALS
SURROGATE RECOVERIES FOR FIELD AND QC
SAMPLES
SURROGATE = DBB

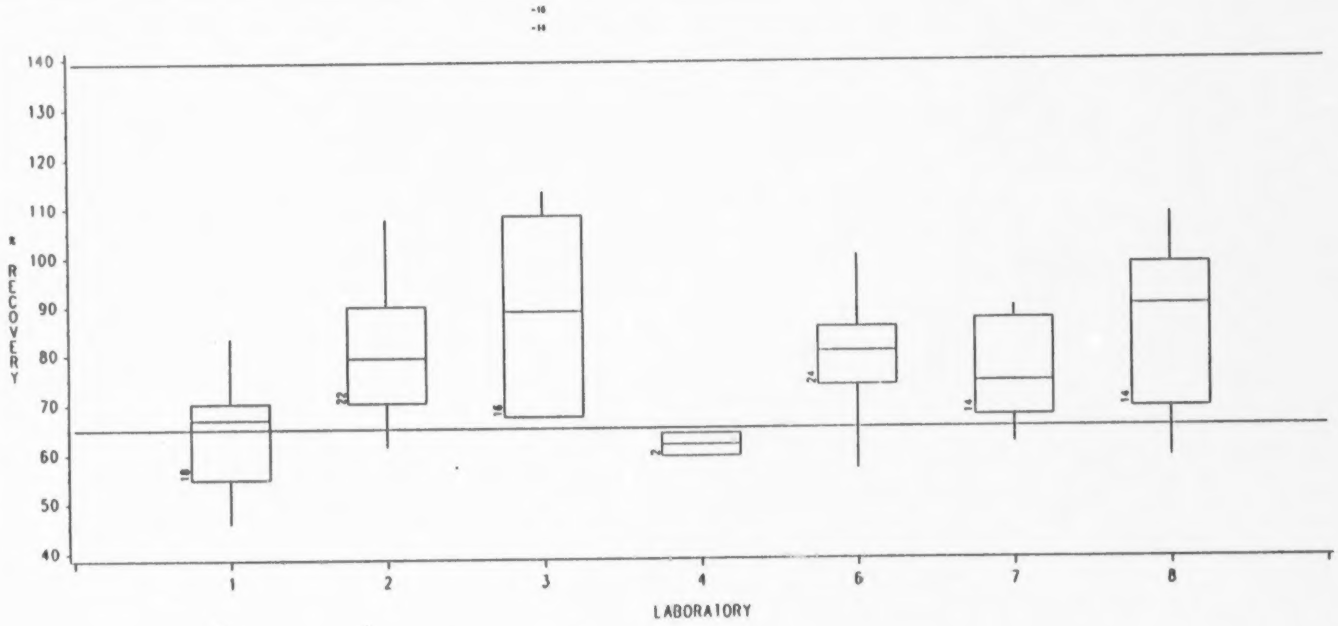


Figure I - 2
SOIL ASSESSMENT--
INDICATOR CHEMICALS.
MATRIX SPOKE RECOVERY SUMMARY
LCIC = ALPHA - BHC

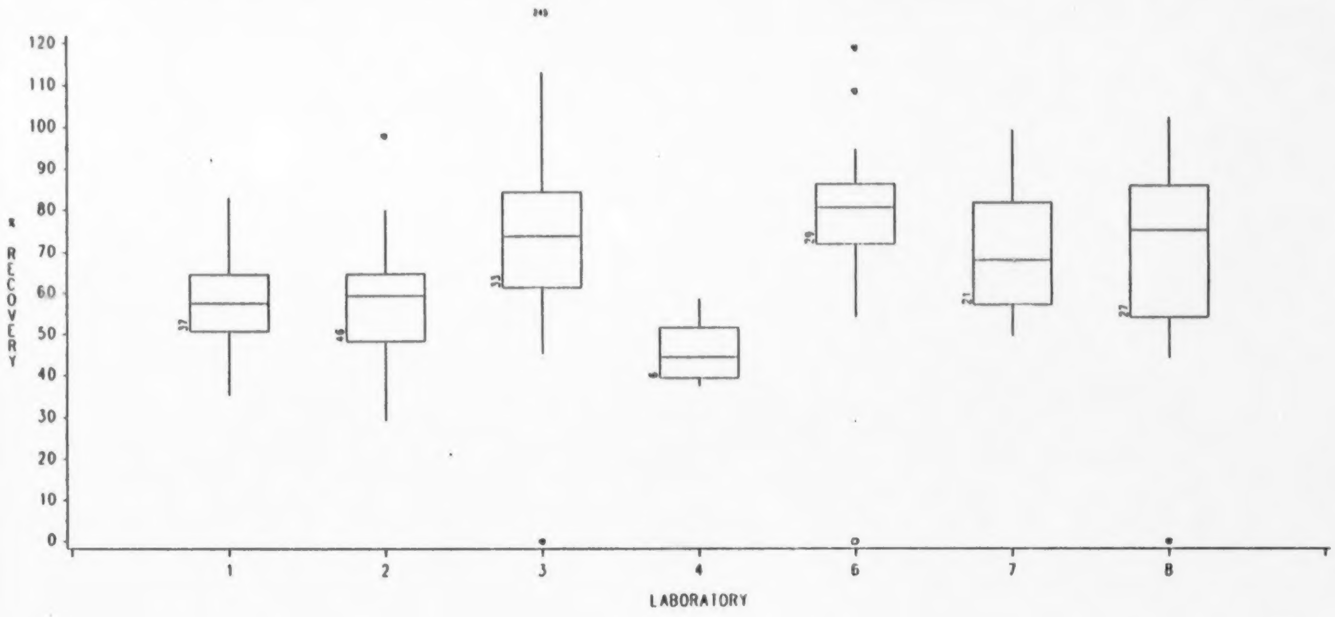


Figure I - 3
SOIL ASSESSMENT--
INDICATOR CHEMICALS
EPA BLIND QUALITY
CONTROL SAMPLE SUMMARY
LCIC = GAMMA - BHC

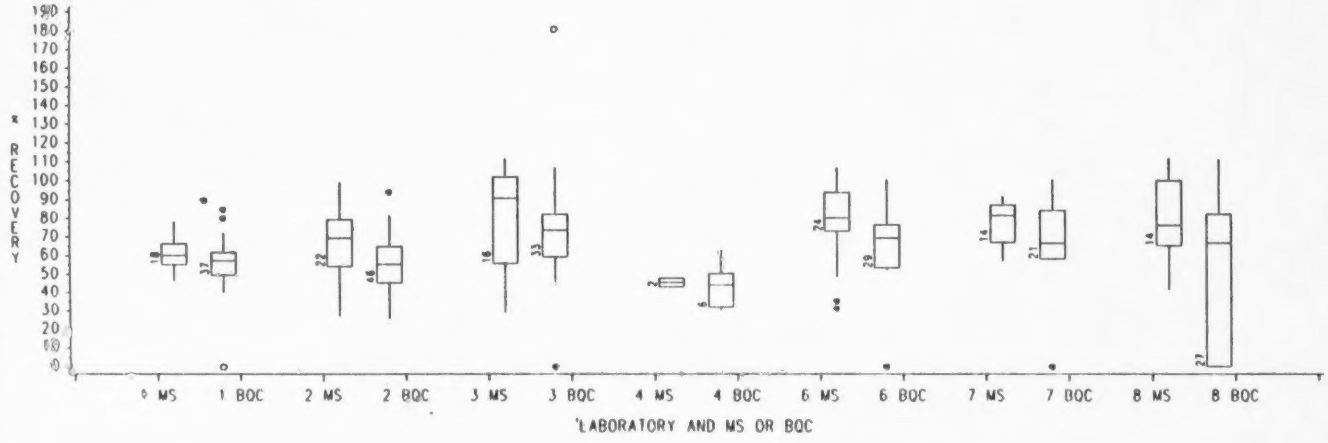


Figure I - 4
SOIL ASSESSMENT--
INDICATOR CHEMICALS
COMPARISON OF MATRIX
SPIKE AND BQC RECOVERIES
LCIC = BETA - BHC

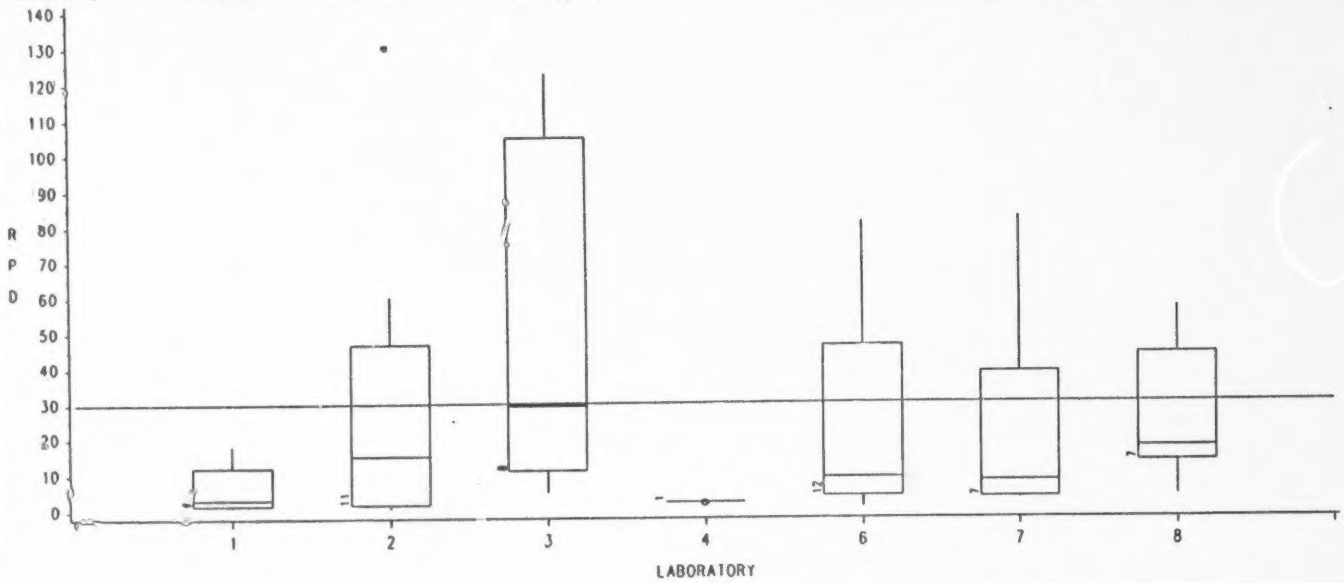


Figure I - 5a
SOIL ASSESSMENT--
INDICATOR CHEMICALS
MATRIX SPIKE RELATIVE
PERCENT DIFFERENCE
SUMMARY
LCIC = CNP

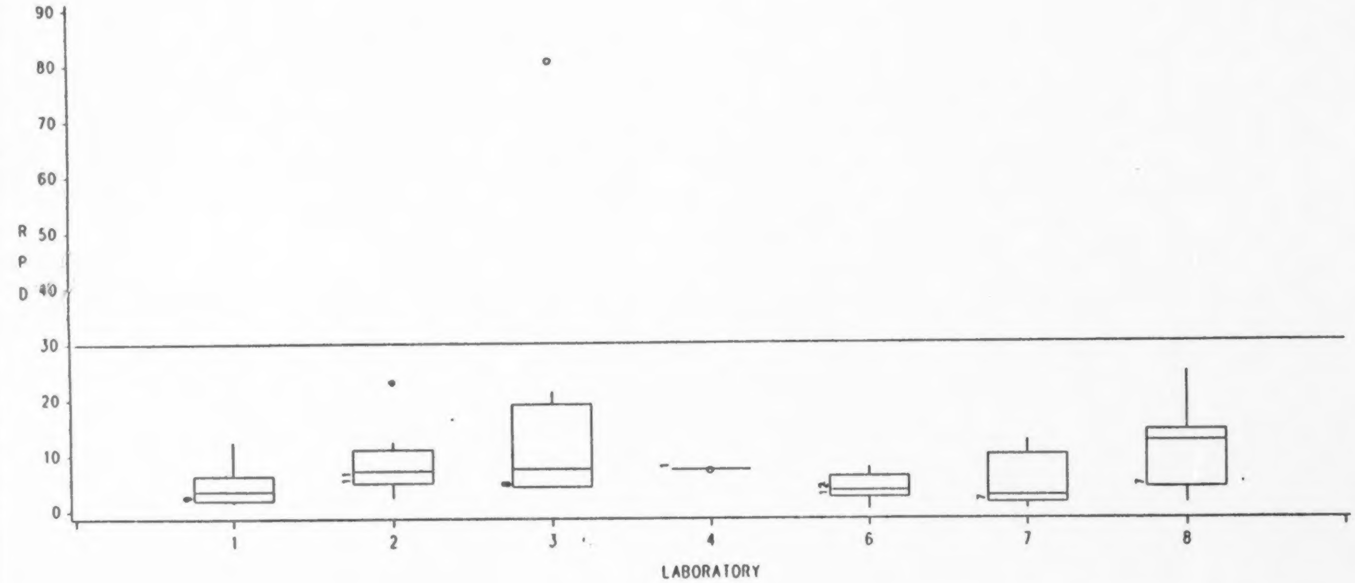
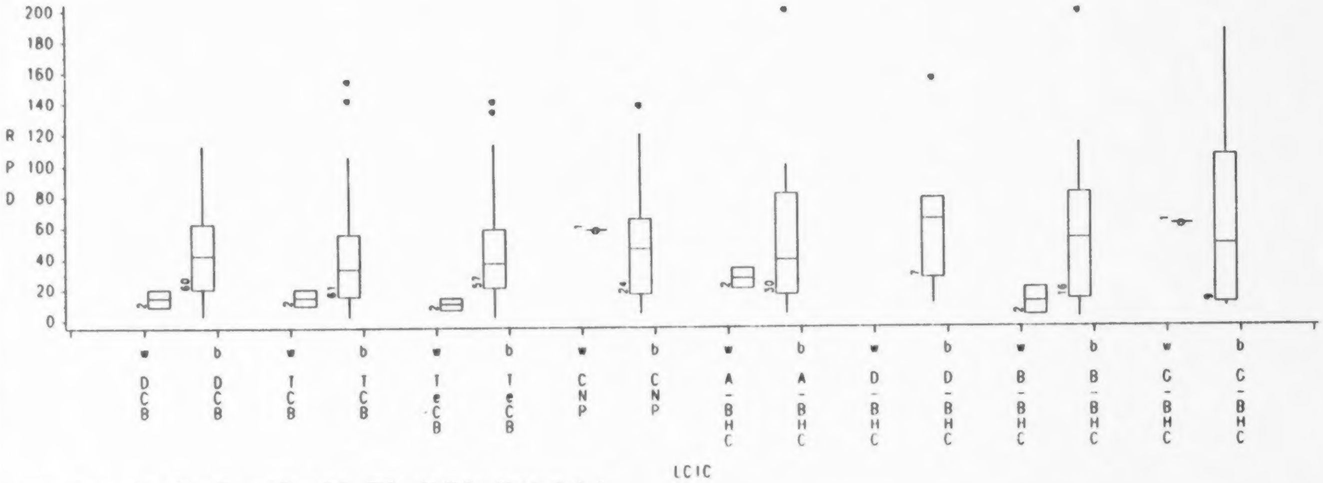


Figure I - 5b
SOIL ASSESSMENT--
INDICATOR CHEMICALS
MATRIX SPIKE RELATIVE
PERCENT DIFFERENCE
SUMMARY
LCIC = ALPHA - BHC



Note: Pairs with a Non-Detect Result for Either Half Are Not Included

Figure I - 6
SOIL ASSESSMENT--
INDICATOR CHEMICALS
RELATIVE PERCENT
DIFFERENCE IN FIELD
SPLIT RESULTS WITHIN
AND BETWEEN LABORATORIES

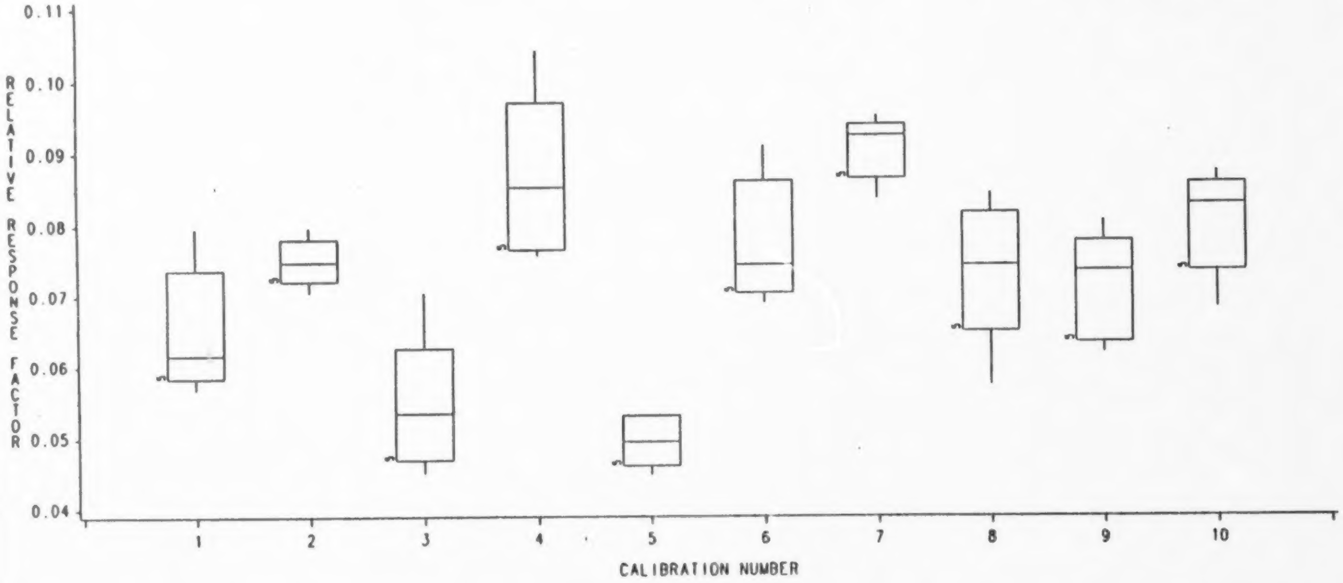


Figure I - 7
SOIL ASSESSMENT--
INDICATOR CHEMICALS
INITIAL CALIBRATION
SUMMARY FOR LABORATORY 3
SURROGATE = TBBP

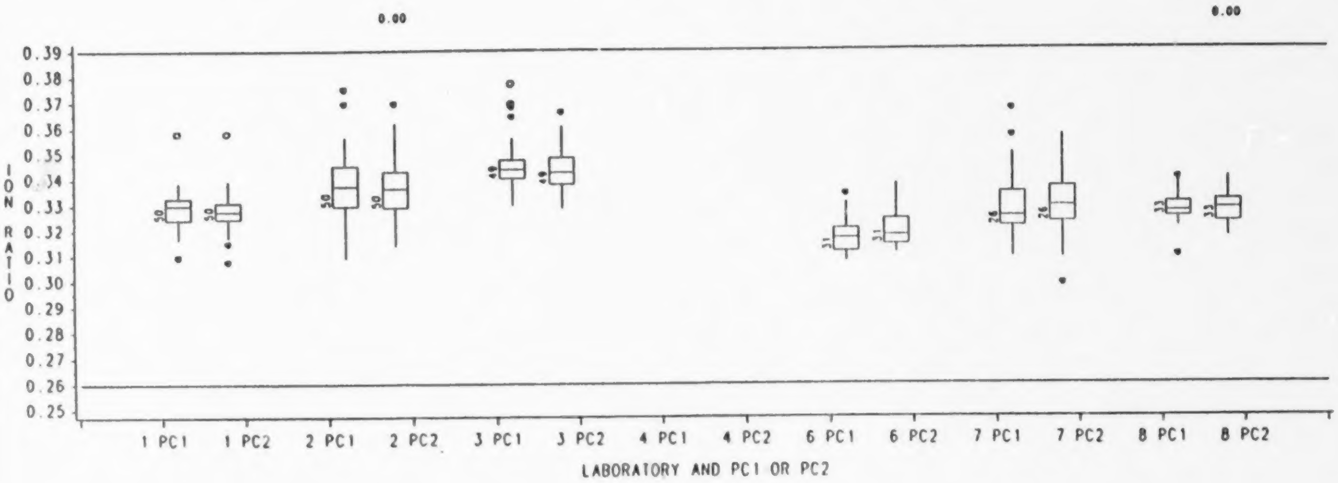


Figure I - 8
SOIL ASSESSMENT--
INDICATOR CHEMICALS
PERFORMANCE CHECK
ION RATIOS
LCIC = CNP

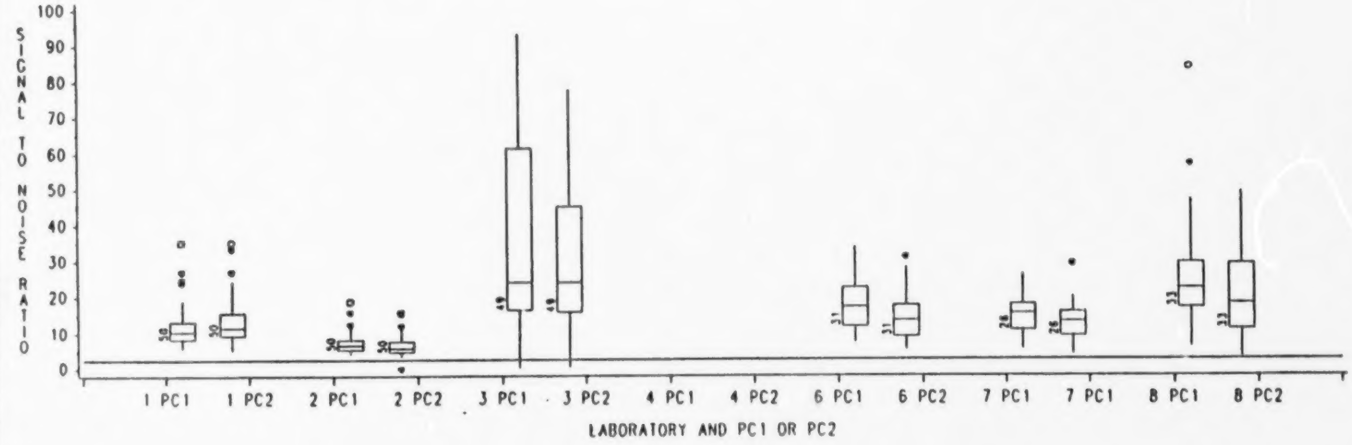


Figure I - 9
SOIL ASSESSMENT--
INDICATOR CHEMICALS
PERFORMANCE CHECK
SENSITIVITY
ON = BETA - BHC 217 ION

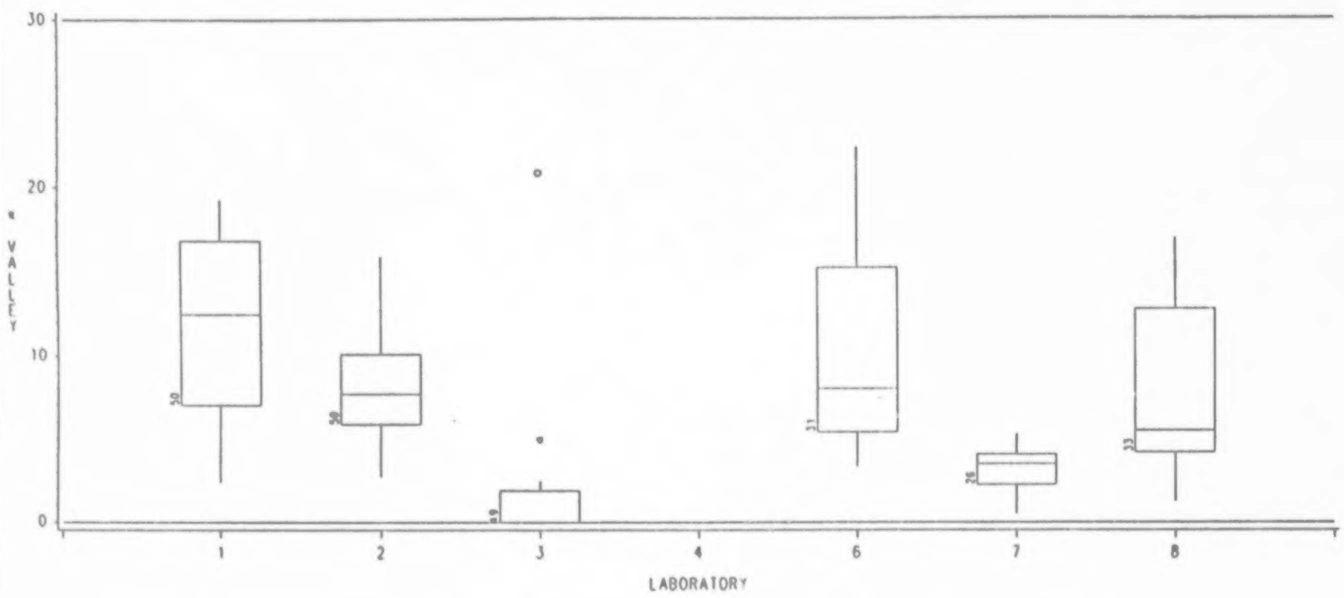


Figure I - 10
SOIL ASSESSMENT--
INDICATOR CHEMICALS
PERFORMANCE CHECK
RESOLUTION
LCIC = CNP - PC1

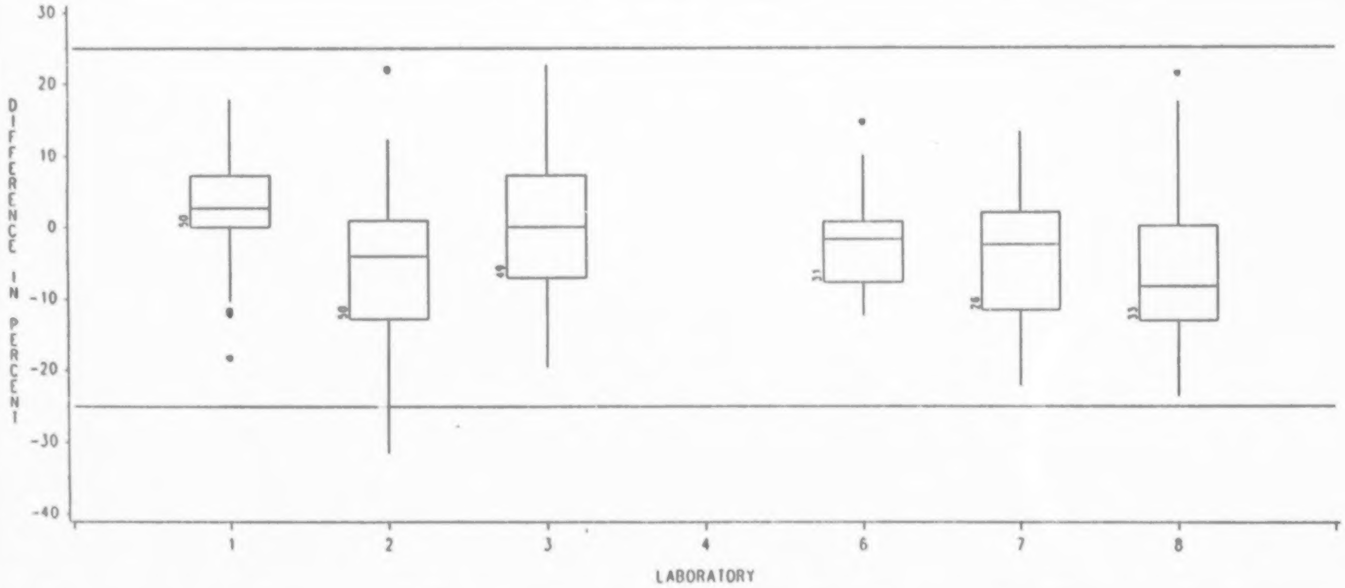


Figure I - 11
SOIL ASSESSMENT--
INDICATOR CHEMICALS
CONTINUING CALIBRATION RF SUMMARY
LCIC = BETA - BHC

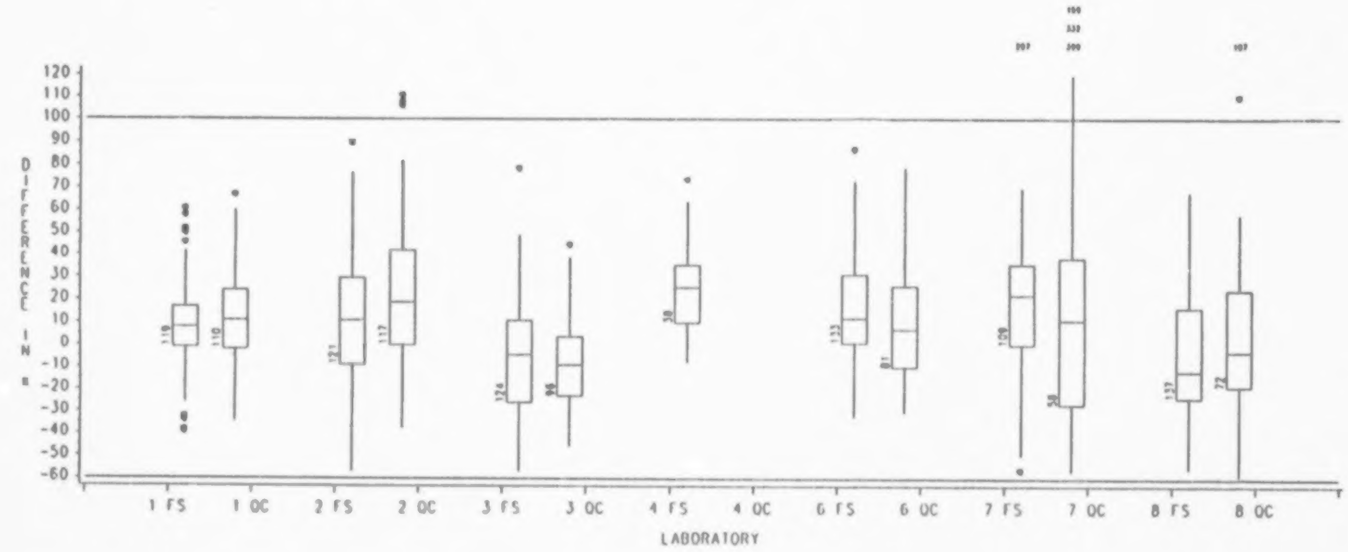
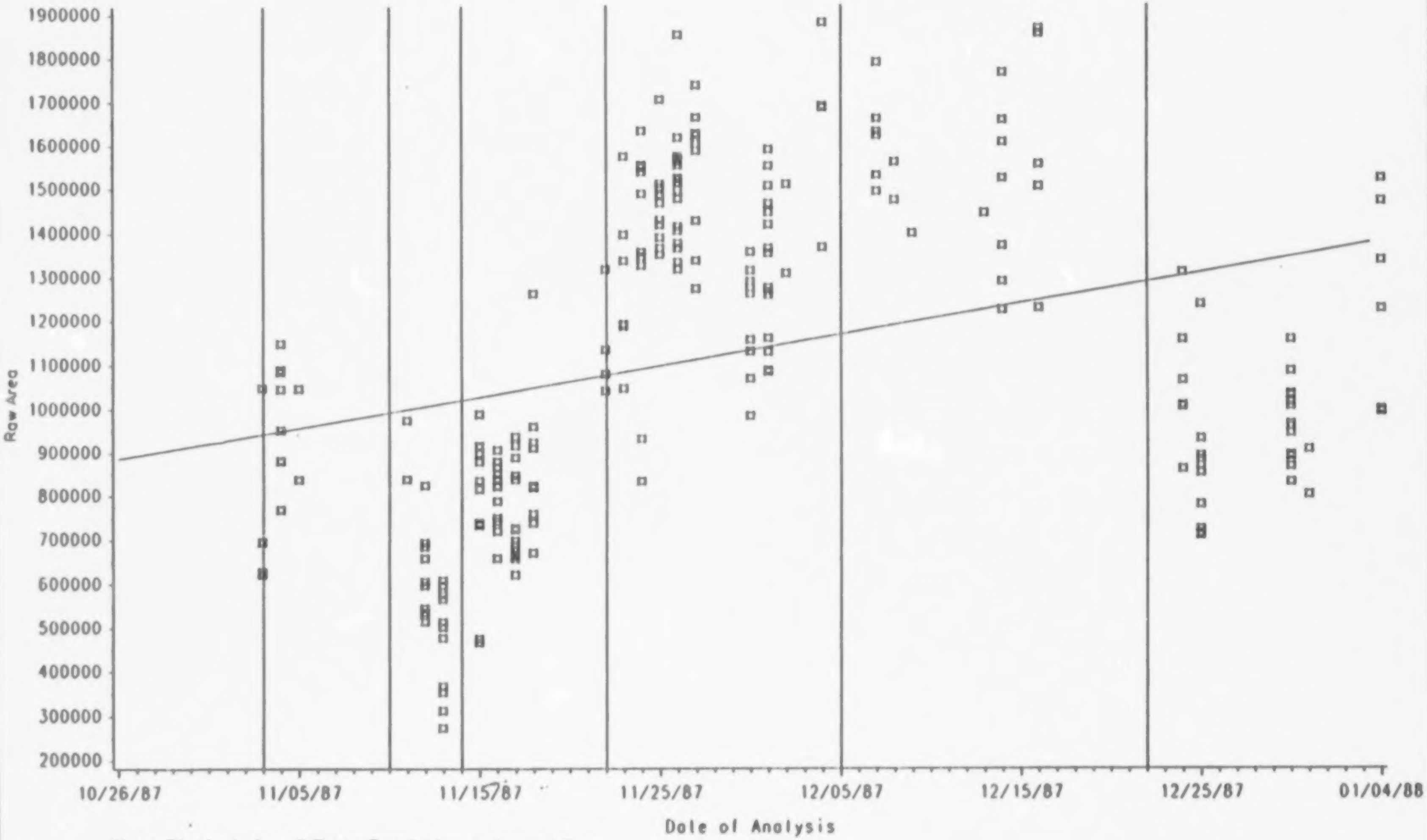
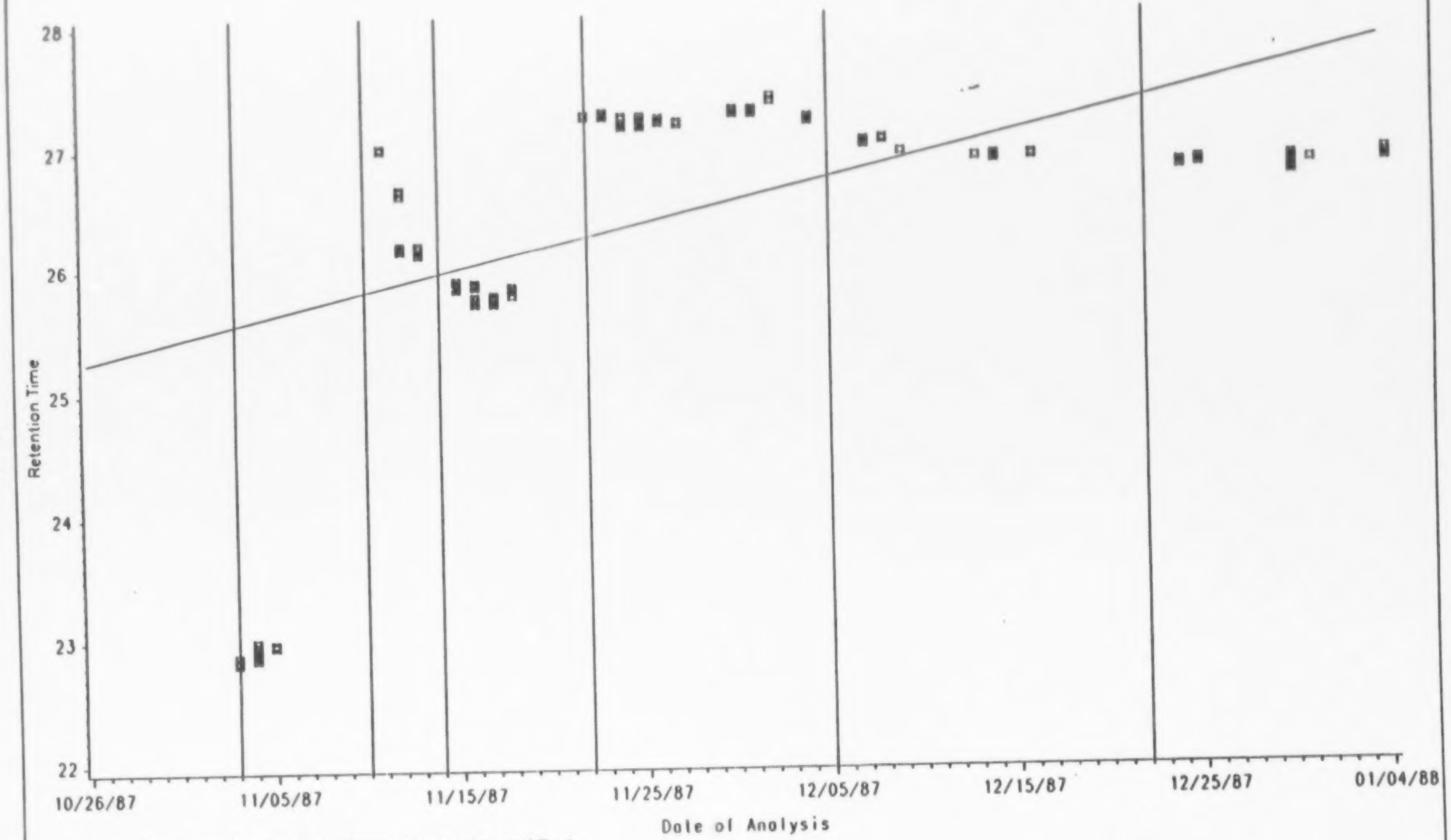


Figure I - 12
SOIL ASSESSMENT--
INDICATOR CHEMICALS
INTERNAL STANDARD
AREA PERCENT VARIATION
IS4 = D10 - PHENANTHRENE



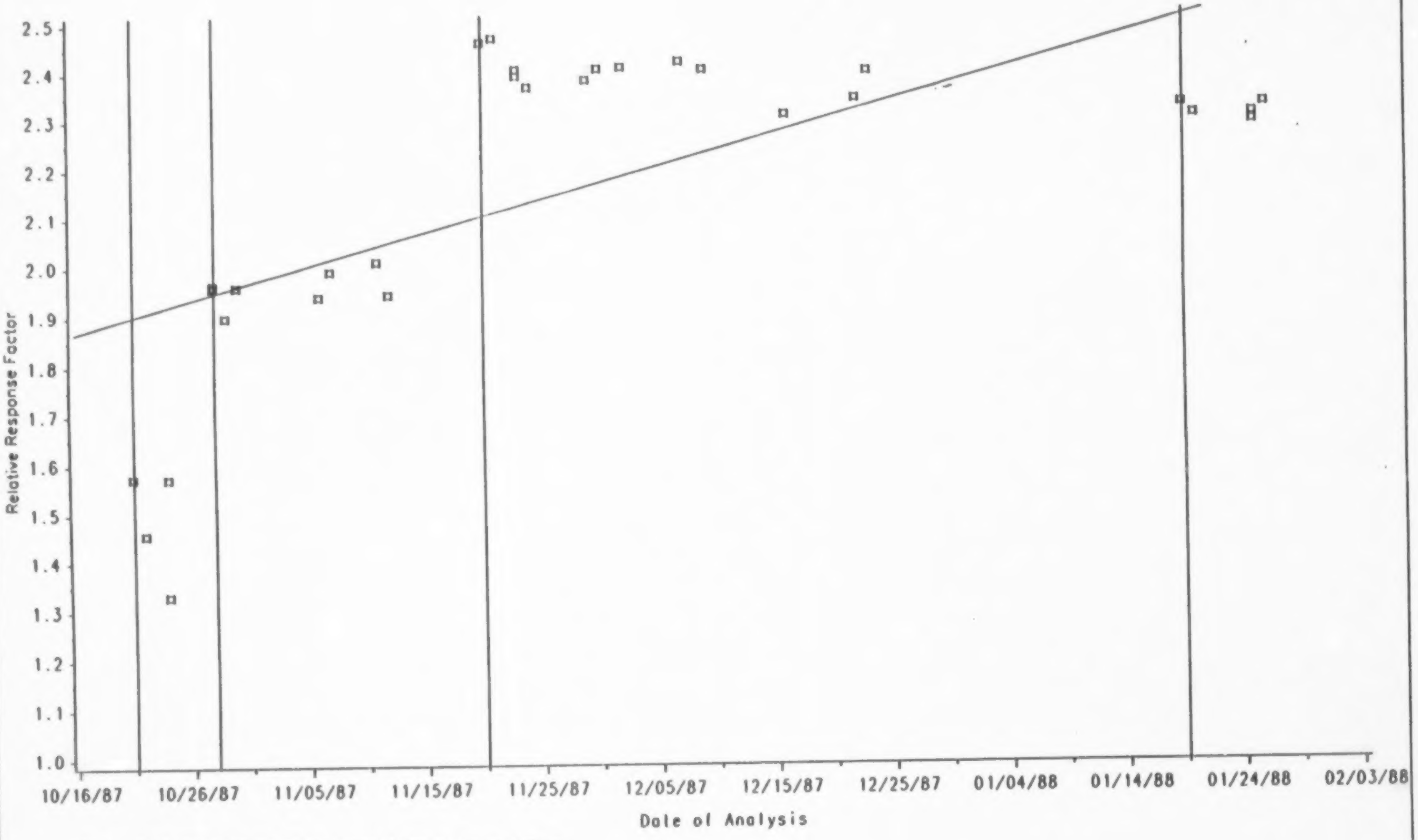
Note: Plot Includes all Data: Good, Uncertain, and Bad.

Figure I-13 SOIL ASSESSMENT -- INDICATOR CHEMICALS
TREND ANALYSIS FOR LABORATORY 1
RAW PEAK AREA FOR D4 - DCB



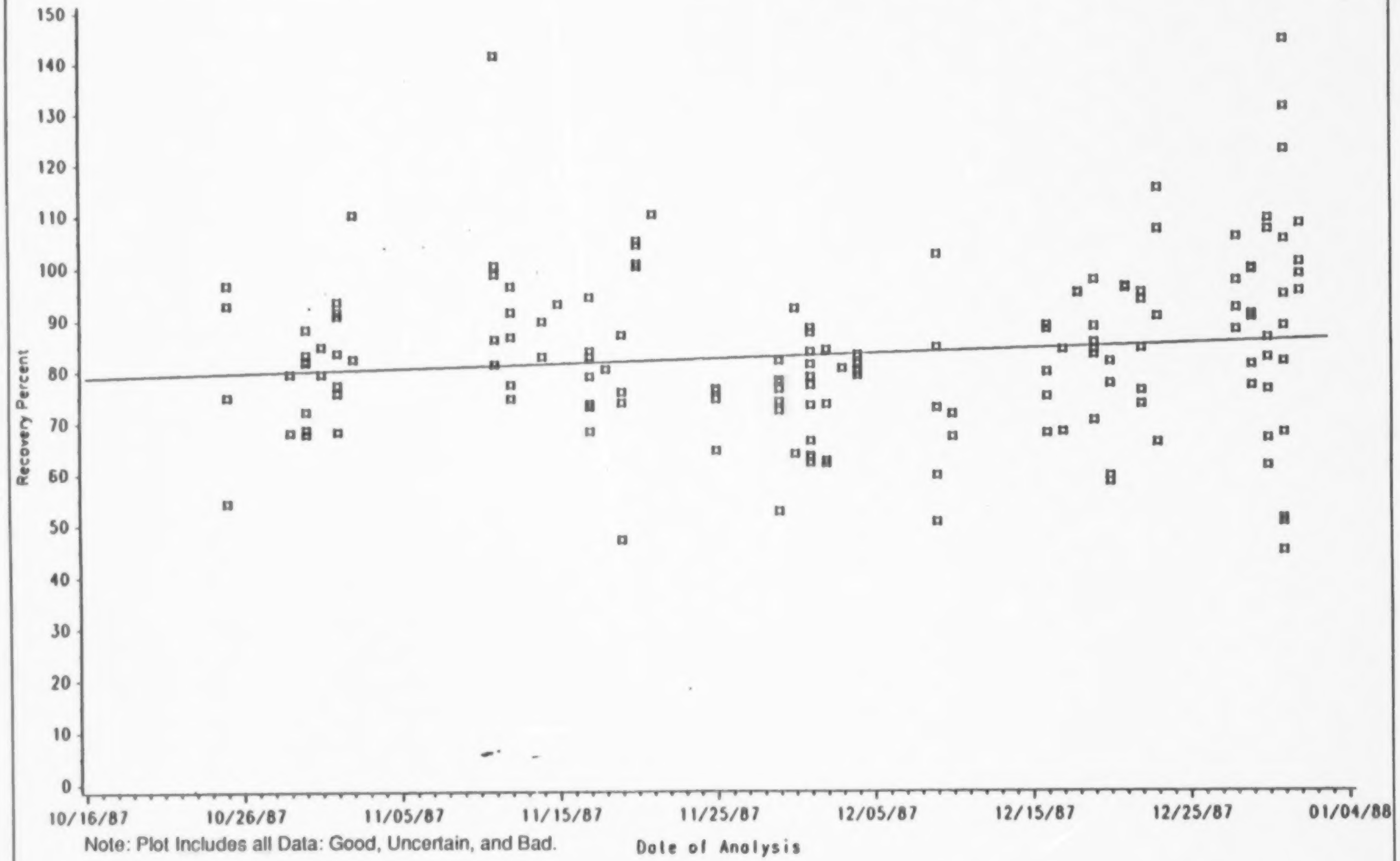
Note: Plot Includes all Data: Good, Uncertain, and Bad.

Figure I-14 SOIL ASSESSMENT -- INDICATOR CHEMICALS
TREND ANALYSIS FOR LABORATORY 1
RAW RETENTION TIME D10 - PYRENE



Note: Plot Includes all Data: Good, Uncertain, and Bad.

Figure I-15 SOIL ASSESSMENT -- INDICATOR CHEMICALS
TREND ANALYSIS FOR LABORATORY 6
LCIC = DCB



Note: Plot Includes all Data: Good, Uncertain, and Bad.

Figure I-16 SOIL ASSESSMENT -- INDICATOR CHEMICALS TREND ANALYSIS FOR LABORATORY 8 SURROGATE NO. 3

APPENDIX J
Sampling Area Comparisons and Additional Sensitivity Analyses

Soil Assessment--Indicator Chemicals

Appendix J
SAMPLING AREA COMPARISONS AND ADDITIONAL SENSITIVITY ANALYSES SOIL ASSESSMENT--INDICATOR CHEMICALS

In response to requests by Dr. Schoenfeld and Dr. Stoline during peer review (June 20 and 21, 1988) and by the TRC, additional comparisons were performed to provide context for the statistical comparisons of the soil LCIC assessment and to examine the sensitivity of the statistical comparisons to the particular data used.

APPROACH

The tables that are presented in this appendix compare all EDA sampling areas and comparison areas. (These tables incorporate Tables 6-8 and 6-9 in Volume III and show comparisons among EDA sampling areas.) Two original sensitivity analyses were reported in Volume III. In addition, three other sensitivity analyses are included in this appendix, and an alternative approach to the comparison of all LCICs is also included here.

The comparisons are presented in a format identical to that in Volume III. The following analyses are presented:

- All EDA sampling areas and comparison areas compared among themselves for each LCIC (univariate test), based only on the observations classified as Good (Table J-1a through c)
- All EDA sampling areas and comparison areas compared among themselves for all LCICs considered together (multivariate test), based only on the observations classified as Good (Table J-2a and b)
- A sensitivity analysis of the results presented in Table J-1a, based on classifying all observations less than or equal to 2.0 ppb as non-detect (Table J-3)
- A sensitivity analysis of the results presented in Table J-1a, based on trimming the upper 10 percent of the data set (Table J-4a through c)
- Percent increase in number of detects, by LCIC, in the Good data due to reclassifying non-detects with an ion ratio between 20 and 40 percent as detects (Table J-5)

- A sensitivity analysis of the results presented in Tables J-1a through c, based on a data set modified by relaxing the ion ratio criterion for identification (detection) (Table J-6a through c)
- A sensitivity analysis of the results presented in Tables J-2a and b, based on the data set modified by relaxing the ion ratio criterion for identification (detection) (Table J-7a and b)
- Comparisons between the EDA sampling areas and the comparison areas for each LCIC (univariate test), with the Bonferroni correction for number of LCICs (Figure J-1)
- Comparisons between each comparison area and the other two comparison areas for LCIC (univariate test), with the Bonferroni correction for number of LCICs (Figure J-2)

DISCUSSION OF RESULTS

COMPARISONS AMONG EDA SAMPLING AREAS

Tables J-1 (a through c) and 2 (a and b) supplement Tables 6-8 and 6-9 of Volume III by including comparisons among EDA sampling areas. Table 6-8 in Volume III lists the results of comparing each of the seven EDA sampling areas and the three comparison areas with the three comparison areas for each LCIC (univariate test), based only on the observations classified as Good. Table 6-9 of Volume III shows the analogous results based on the multivariate test. Neither table shows comparisons between EDA sampling areas. Following the request of the TRC, Tables J-1 and 2 provide the results of comparisons of EDA sampling area to EDA sampling area.

TRIMMING DATA BELOW 2.0 PPB

In addition to the two sensitivity analyses presented in Volume III, a new sensitivity analysis is also presented here. At the request of a peer reviewer (Dr. David Schoenfeld--Peer Review Meeting Comment, June 21, 1988), the additional sensitivity analysis was performed in which all data below 2.0 ppb were classified as non-detects. Table J-3 shows the results of this analysis.

The purpose of this sensitivity analysis is similar to that of the sensitivity analysis reported in Volume III in which all concentrations less than 1.0 ppb were treated as non-detects. The purpose, as stated in Volume III (p. 5-10), is to assess the sensitivity of the comparisons to the laboratory detection limits. "If the results had changed dramatically with the [artificially] increased detection limits, then it could be concluded that the detection limits were exerting a strong influence on the results" (Volume III, p. 5-10).

Since most observations are less than 1.0 ppb for all of the LCICs except tri- and tetrachlorobenzene, the 1.0-ppb cutoff was used in the original sensitivity analysis. Since for the LCICs TCB and TeCB, most observations are less than 2.0 ppb, Dr. Schoenfeld requested that the analysis treating data below 2.0 ppb as non-detects be performed.

These sensitivity analyses which treat near-detection limit values as non-detect address another issue as well. Because most observations are less than 1.0 or 2.0 ppb for most LCICs, the effect of treating all observations less than or equal to 1.0 or 2.0 ppb as non-detect is to emphasize the characteristic of the Wilcoxon rank sum test, which tests for differences in the upper tails of the distributions. That is, this sensitivity analysis can be used to test whether there are more outlying high values in one EDA sampling or comparison area than in another.

TRIMMING THE UPPER 10 PERCENT OF THE DATA

The "upper 10 percent trimmed" data set used to produce Table J-4 (a through c) consists of the original data set modified by deleting the largest 10 percent of the observations in each comparison and EDA sampling area.

The purpose of deleting the upper 10 percent of the data in each area is to explore the effects of treating the largest 10 percent of the observations in each EDA sampling area and comparison area as outliers. The question this sensitivity analysis proposes to answer is whether a few large values in any particular EDA sampling or comparison area will have a great influence on the outcome of the statistical comparisons. It should be noted that it is not possible to perform a meaningful multivariate analysis based on an upper 10 percent trim of the multivariate observations, because an upper 10 percent trim is not well-defined for a multivariate observation. For any particular EDA sampling or comparison area, the samples with the largest 10 percent of the observations for one LCIC may not correspond to the largest 10 percent of the observations for another LCIC.

RELAXING ION RATIO CRITERION

The data set used to produce Tables J-5, 6 (a through c), and 7 (a and b) include the original data set, and it has been modified in the following way: non-detect observations classified as non-detect solely because the observed ratio of primary to secondary ions deviated from the theoretical ratio by more than 20 percent but less than 40 percent were reclassified as detect, and the primary ion concentration has been used to estimate the concentration of the LCIC. (Note that three other criteria were used to establish whether an observation was recorded as detect or non-detect. These were (1) all three ions present, (2) the peaks for the three ions all within two scans of each other, and (3) the peaks for the three ions all within the ± 0.005 relative retention time window. If an observation failed any of these three criteria, it remained classified as a non-detect in the modified data set.) Table J-5 shows the percent increase in number of detects, by LCIC, for the Good data based on the reclassification of non-detects using the criteria described above. The purpose of generating Tables J-6 (a through c) and 7 (a and b) is to explore the effects of LCIC interferences on the statistical comparisons.

BONFERRONI CORRECTION

At the request of another peer reviewer (Dr. Michael Stoline--Written Preliminary Comments, p. 10), an alternative version of Figure 6-9 of Volume III is presented in Figure J-1, in which the results of the statistical comparisons are modified using a Bonferroni correction (Miller, 1966) over the eight LCICs. The Bonferroni method is an alternative to the multivariate approach (Figure 6-10 of Volume III) to the multiple comparisons problem (see Appendix A of Volume III).

For the original comparisons, shown in Figure 6-9, an EDA sampling area has been determined to be statistically significantly different from a comparison area (indicated by an up or down arrow) if the two-sided p-value of the statistic associated with that comparison (p-values are given in Table K-1) was less than or equal to 0.05. The direction of the arrow is determined by the sign of the statistic. The Bonferroni approach guarantees that the overall alpha-level for the eight tests associated with comparing a particular EDA sampling area to a particular comparison area (one test for each LCIC) is no more than 0.05. That is, the probability of at least one false positive (EDA concentration incorrectly assumed to be larger than comparison area concentration) or false negative (EDA concentration incorrectly assumed to be less than comparison area concentration) among the eight tests is no more than 5 percent.

For the comparisons shown in Figure J-1 of this appendix, an EDA sampling area is determined to be statistically significantly different from a comparison area if the two-sided p-value of the statistic associated with that comparison is less than or equal to (0.05/8) = 0.00625.

CENTRAL ANALYSIS

Although the additional comparisons have been made, it should be emphasized that the peer review committee has recommended that the results of the original comparisons (given in Tables 6-8, 6-9, 6-10, K-1, and K-2, and Figures 6-9, 6-10, and 6-11 of Volume III) should be the primary basis for the habitability decision (Dr. David Schoenfeld--Peer Review Meeting Comment, June 21, 1988).

WDR356/008

REFERENCE

Miller, Rupert G. 1966. Simultaneous Statistical Inference. McGraw-Hill Book Co., New York.

WDR356/008

Table J-1a

RESULTS FOR NONPARAMETRIC UNIVARIATE SAMPLING/ COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS[a,b,c,d,e]

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			1.01	0.39	0.40	0.36	0.39	0.36	0.41	0.39	0.43	0.36
DCB	1	1.01		--	--	--	--	--	--	--	--	--
	2	0.39	++		o	--	o	o	o	o	o	--
	3	0.40	++	o		--	o	-	o	o	o	--
	4	0.36	++	++	++		+	o	++	++	+	o
	5	0.39	++	o	o	-		-	o	o	o	o
	6	0.36	++	o	+	o	+		+	++	o	o
	7	0.41	++	o	o	--	o	-		o	o	-
	221	0.39	++	o	o	--	o	--	o		o	--
	225	0.43	++	o	o	-	o	o	o	o		o
	C&T	0.36	++	++	++	o	o	o	+	++	o	
			8.67	0.91	0.89	0.43	0.52	0.37	0.58	0.65	0.60	0.13
TCB	1	8.67		--	--	--	--	--	--	--	--	--
	2	0.91	++		o	--	--	--	--	--	--	--
	3	0.89	++	o		--	-	--	--	-	-	--
	4	0.43	++	++	++		o	o	o	+	o	--
	5	0.52	++	++	+	o		--	o	o	o	--
	6	0.37	++	++	++	o	++		++	++	++	--
	7	0.58	++	++	++	o	o	--		o	o	--
	221	0.65	++	++	+	-	o	--	o		o	--
	225	0.60	++	++	+	o	o	--	o	o		--
	C&T	0.13	++	++	++	++	++	++	++	++	++	
			11.48	1.17	1.06	0.38	0.43	0.31	0.54	0.53	0.61	0.05
TeCB	1	11.48		--	--	--	--	--	--	--	--	--
	2	1.17	++		o	--	--	--	--	--	--	--
	3	1.06	++	o		--	--	--	--	--	--	--
	4	0.38	++	++	++		o	o	o	+	o	--
	5	0.43	++	++	++	o		--	o	o	o	--
	6	0.31	++	++	++	o	++		++	++	++	--
	7	0.54	++	++	++	o	o	--		o	o	--
	221	0.53	++	++	++	-	o	--	o		o	--
	225	0.61	++	++	++	o	o	--	o	o		--
	C&T	0.05	++	++	++	++	++	++	++	++	++	

Table J-1a
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			ND	0.04	0.04	0.04	0.06	0.05	0.06	0.06	0.07	0.03
CNP	1	ND		o	o	o	o	o	o	o	+	o
	2	0.04	o		o	o	o	o	o	o	+	o
	3	0.04	o	o		o	o	o	+	o	++	o
	4	0.04	o	o	o		o	o	o	o	o	o
	5	0.06	o	o	o	o		o	o	o	+	o
	6	0.05	o	o	o	o	o		o	o	o	o
	7	0.06	o	o	-	o	o	o		o	o	-
	221	0.06	o	o	o	o	o	o	o		o	o
	225	0.07	-	-	--	o	-	o	o	o		-
	C&T	0.03	o	o	o	o	o	o	+	o	+	
			8.25	0.40	0.22	0.12	0.13	0.07	0.14	0.18	0.11	ND
a-BHC	1	8.25		--	--	--	--	--	--	--	--	--
	2	0.40	++		-	--	--	--	--	--	--	--
	3	0.22	++	+		o	-	--	-	o	o	--
	4	0.12	++	++	o		o	o	o	o	o	--
	5	0.13	++	++	+	o		o	o	o	o	--
	6	0.07	++	++	++	o	o		+	+	o	--
	7	0.14	++	++	+	o	o	-		o	o	--
	221	0.18	++	++	o	o	o	-	o		o	--
	225	0.11	++	++	o	o	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
			1.13	0.04	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	1	1.13		--	--	--	--	--	--	--	--	--
	2	0.04	++		-	--	--	--	--	--	--	--
	3	ND	++	+		o	o	--	--	--	o	--
	4	ND	++	++	o		o	o	o	-	o	--
	5	ND	++	++	o	o		-	o	-	o	--
	6	ND	++	++	++	o	+		o	o	o	--
	7	ND	++	++	++	o	o	o		o	o	--
	221	ND	++	++	++	+	+	o	o		o	o
	225	ND	++	++	o	o	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	o	++	
			11.58	0.20	0.13	ND	ND	ND	ND	ND	ND	ND
b-BHC	1	11.58		--	--	--	--	--	--	--	--	--
	2	0.20	++		o	o	--	--	--	--	o	--
	3	0.13	++	o		o	-	--	o	--	o	--
	4	ND	++	o	o		o	--	o	-	o	--
	5	ND	++	++	+	o		o	o	o	o	--
	6	ND	++	++	++	++	o		++	o	++	--
	7	ND	++	++	o	o	o	--		o	o	--
	221	ND	++	++	++	+	o	o	o		+	--
	225	ND	++	o	o	o	o	--	o	-		--
	C&T	ND	++	++	++	++	++	++	++	++	++	

Table J-1a
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas 1	2	3	4	5	6	7	Comparison Areas 221	225	C&T
			1.73	0.09	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC	1	1.73		--	--	--	--	--	--	--	--	--
	2	0.09	++		o	-	--	--	--	--	-	--
	3	ND	++	o		o	-	--	--	--	o	--
	4	ND	++	+	o		o	-	o	-	o	--
	5	ND	++	++	+	o		o	o	o	o	--
	6	ND	++	++	++	+	o		o	o	+	--
	7	ND	++	++	++	o	o	o		o	o	--
	221	ND	++	++	++	+	o	o	o		o	--
	225	ND	++	+	o	o	o	-	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
TOTALS	++		63	40	26	7	8	6	10	10	10	0
	+		0	4	8	4	4	0	5	3	7	0
	o		8	20	27	39	41	27	39	36	41	12
	-		1	1	3	5	5	8	1	6	2	3
	--		0	7	8	17	14	31	17	17	12	57
All Symbols			72	72	72	72	72	72	72	72	72	72

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a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
 + = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
 o = No significant difference at 0.05 significance level.
 - = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
 -- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. The first entry in each column is median concentration; ND indicates non-detect.

d. 221 = Census Tract 221.
 225 = Census Tract 225.
 C&T = Cheektowaga and Tonawanda.

e. Based on observations classified as Good.

Table J-1b

TWO-SIDED p-VALUES FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS[a,b]

LCIC	Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
DCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.989	0.004	0.413	0.052	0.564	0.805	0.539	0.008
	3	0.000	0.989	1.000	0.005	0.682	0.041	0.740	0.980	0.583	0.002
	4	0.000	0.004	0.005	1.000	0.029	0.349	0.003	0.003	0.025	0.915
	5	0.000	0.413	0.682	0.029	1.000	0.044	0.639	0.617	0.779	0.058
	6	0.000	0.052	0.041	0.349	0.044	1.000	0.035	0.009	0.312	0.146
	7	0.000	0.564	0.740	0.003	0.639	0.035	1.000	0.992	0.556	0.022
	221	0.000	0.805	0.980	0.003	0.617	0.009	0.992	1.000	0.757	0.007
	225	0.000	0.539	0.583	0.025	0.779	0.312	0.556	0.757	1.000	0.194
	C&T	0.000	0.008	0.002	0.915	0.058	0.146	0.022	0.007	0.194	1.000
TCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.245	0.000	0.001	0.000	0.000	0.001	0.010	0.000
	3	0.000	0.245	1.000	0.000	0.041	0.000	0.002	0.014	0.032	0.000
	4	0.000	0.000	0.000	1.000	0.140	0.219	0.089	0.011	0.077	0.000
	5	0.000	0.001	0.041	0.140	1.000	0.002	0.964	0.268	0.828	0.000
	6	0.000	0.000	0.000	0.219	0.002	1.000	0.000	0.000	0.005	0.000
	7	0.000	0.000	0.002	0.089	0.964	0.000	1.000	0.123	0.808	0.000
	221	0.000	0.001	0.014	0.011	0.268	0.000	0.123	1.000	0.368	0.000
	225	0.000	0.010	0.032	0.077	0.828	0.005	0.808	0.368	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
TeCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.069	1.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000
	4	0.000	0.000	0.000	1.000	0.404	0.127	0.055	0.040	0.054	0.000
	5	0.000	0.000	0.000	0.404	1.000	0.006	0.228	0.446	0.250	0.000
	6	0.000	0.000	0.000	0.127	0.006	1.000	0.000	0.000	0.000	0.000
	7	0.000	0.000	0.000	0.055	0.228	0.000	1.000	0.446	0.982	0.000
	221	0.000	0.000	0.000	0.040	0.446	0.000	0.446	1.000	0.346	0.000
	225	0.000	0.000	0.005	0.054	0.250	0.000	0.982	0.346	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
CNP	1	1.000	0.964	0.815	0.275	0.519	0.175	0.181	0.110	0.047	0.693
	2	0.964	1.000	0.964	0.657	0.403	0.128	0.107	0.055	0.013	0.914
	3	0.815	0.964	1.000	0.155	0.593	0.207	0.022	0.059	0.005	0.814
	4	0.275	0.657	0.155	1.000	0.599	0.789	0.246	0.597	0.107	0.103
	5	0.519	0.403	0.593	0.599	1.000	0.305	0.166	0.311	0.018	0.605
	6	0.175	0.128	0.207	0.789	0.305	1.000	0.368	0.383	0.322	0.193
	7	0.181	0.107	0.022	0.246	0.166	0.368	1.000	0.965	0.762	0.018
	221	0.110	0.055	0.059	0.597	0.311	0.383	0.965	1.000	0.824	0.091
	225	0.047	0.013	0.005	0.107	0.018	0.322	0.762	0.824	1.000	0.010
	C&T	0.693	0.914	0.814	0.103	0.605	0.193	0.018	0.091	0.010	1.000
a-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.011	0.003	0.000	0.000	0.000	0.000	0.001	0.000
	3	0.000	0.011	1.000	0.260	0.045	0.000	0.041	0.069	0.207	0.000
	4	0.000	0.003	0.260	1.000	0.617	0.069	0.890	0.630	0.410	0.000
	5	0.000	0.000	0.045	0.623	1.000	0.164	0.516	0.270	0.942	0.000
	6	0.000	0.000	0.000	0.069	0.164	1.000	0.029	0.028	0.192	0.000
	7	0.000	0.000	0.041	0.890	0.516	0.029	1.000	0.509	0.577	0.000
	221	0.000	0.000	0.069	0.630	0.270	0.028	0.509	1.000	0.346	0.000
	225	0.000	0.001	0.207	0.410	0.942	0.192	0.577	0.346	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Table J-1b
(continued)

LCIC	Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
d-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.018	1.000	0.063	0.220	0.001	0.008	0.000	0.150	0.000
	4	0.000	0.000	0.063	1.000	0.829	0.108	0.351	0.032	0.573	0.000
	5	0.000	0.000	0.220	0.829	1.000	0.034	0.169	0.015	0.560	0.000
	6	0.000	0.000	0.001	0.108	0.034	1.000	0.474	0.563	0.372	0.008
	7	0.000	0.000	0.008	0.351	0.169	0.474	1.000	0.206	0.667	0.002
	221	0.000	0.000	0.000	0.032	0.015	0.563	0.206	1.000	0.075	0.070
	225	0.000	0.000	0.150	0.573	0.560	0.372	0.667	0.075	1.000	0.001
	C&T	0.000	0.000	0.000	0.000	0.000	0.008	0.002	0.070	0.001	1.000
b-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.348	0.188	0.001	0.000	0.001	0.000	0.105	0.000
	3	0.000	0.348	1.000	0.335	0.012	0.000	0.079	0.000	0.460	0.000
	4	0.000	0.188	0.335	1.000	0.051	0.000	0.411	0.016	0.755	0.000
	5	0.000	0.001	0.012	0.051	1.000	0.099	0.293	0.453	0.118	0.000
	6	0.000	0.000	0.000	0.000	0.099	1.000	0.002	0.247	0.001	0.004
	7	0.000	0.001	0.079	0.411	0.293	0.002	1.000	0.072	0.632	0.000
	221	0.000	0.000	0.000	0.016	0.453	0.247	0.072	1.000	0.033	0.000
	225	0.000	0.105	0.460	0.755	0.118	0.001	0.632	0.033	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	1.000
g-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.338	0.030	0.001	0.000	0.000	0.000	0.014	0.000
	3	0.000	0.338	1.000	0.156	0.038	0.000	0.002	0.001	0.179	0.000
	4	0.000	0.030	0.156	1.000	0.404	0.011	0.098	0.020	0.711	0.000
	5	0.000	0.001	0.038	0.404	1.000	0.158	0.466	0.278	0.461	0.000
	6	0.000	0.000	0.000	0.011	0.158	1.000	0.434	0.921	0.035	0.002
	7	0.000	0.000	0.002	0.098	0.466	0.434	1.000	0.457	0.140	0.000
	221	0.000	0.000	0.001	0.020	0.278	0.921	0.457	1.000	0.095	0.007
	225	0.000	0.014	0.179	0.711	0.461	0.035	0.140	0.095	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.007	0.000	1.000

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a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

Table J-1c
SUMMARY OF NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON TO SAMPLING/COMPARISON AREA COMPARISONS[a,b,c,d]

Sampling/ Comparison Area		Totals Over All LCICs									
		EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
1	++		0	0	0	0	0	0	0	0	0
	+		0	0	0	0	0	0	0	1	0
	o		1	1	1	1	1	1	1	0	1
	-		0	0	0	0	0	0	0	0	0
	--		7	7	7	7	7	7	7	7	7
2	++	7		0	0	0	0	0	0	0	0
	+	0		0	0	0	0	0	0	1	0
	o	1		6	2	2	2	2	2	2	1
	-	0		2	1	0	0	0	0	1	0
	--	0		0	5	6	6	6	6	4	7
3	++	7	0		0	0	0	0	0	1	0
	+	0	2		0	0	0	1	0	0	0
	o	1	6		0	3	1	2	3	5	1
	-	0	0		5	4	1	1	1	1	0
	--	0	0		3	1	6	4	4	1	7
4	++	7	5	3		0	0	1	1	0	0
	+	0	1	0		1	0	0	2	1	0
	o	1	2	5		7	6	7	2	7	2
	-	0	0	0		0	1	0	3	0	0
	--	0	0	0		0	1	0	0	0	0
5	++	7	6	1	0		0	0	0	0	0
	+	0	0	4	0		0	0	0	1	0
	o	1	2	3	8		4	8	6	7	2
	-	0	0	0	0		2	0	2	0	0
	--	0	0	0	0		2	0	0	0	6
6	++	7	6	6	1	2		3	2	3	0
	+	0	0	1	1	2		2	1	1	0
	o	1	2	1	6	4		3	4	4	2
	-	0	0	0	0	0		0	0	0	0
	--	0	0	0	0	0		0	0	0	6
7	++	7	6	4	0	0	0		0	0	0
	+	0	0	1	0	0	0		0	0	0
	o	1	2	2	7	8	3		8	8	0
	-	0	0	1	0	0	2		0	0	2
	--	0	0	0	1	0	3		0	0	6

Table J-1c
(continued)

Sampling/ Comparison Area		Totals Over All LCICs									
		EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
8	++	7	6	4	0	0	0	0		1	0
	+	0	0	1	3	0	0	0		0	0
	o	1	2	3	2	8	4	8		7	2
	-	0	0	0	2	0	1	0		0	0
	--	0	0	0	1	0	3	0		0	6
9	++	7	4	1	0	0	0	0	0		0
	+	0	1	1	0	0	0	0	0		0
	o	0	2	5	7	7	4	8	7		1
	-	1	1	0	1	1	1	0	1		1
	--	0	0	1	0	0	3	0	0		6
10	++	7	7	7	6	6	6	6	6	7	
	+	0	0	0	0	0	0	2	0	0	
	o	1	1	1	2	2	2	0	2	1	
	-	0	0	0	0	0	0	0	0	0	
	--	0	0	0	0	0	0	0	0	0	

---

a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

Table J-2a
RESULTS FOR NONPARAMETRIC MULTIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS[a,b,c,d]

Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
	1	2	3	4	5	6	7	221	225	C&T
1		--	--	--	--	--	--	--	--	--
2	++		o	--	--	--	--	--	--	--
3	++	o		--	--	--	--	--	-	--
4	++	++	++		o	o	++	++	o	--
5	++	++	++	o		o	+	-	+	--
6	++	++	++	o	o		++	++	+	--
7	++	++	++	--	-	--		--	o	--
221	++	++	++	--	+	--	++		+	--
225	++	++	+	o	-	-	o	-		--
C&T	++	++	++	++	++	++	++	++	++	

---

a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling comparison area at 0.01 significance level.

b. The direction of the difference between the EDA Neighborhoods and Comparison Areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

WDR357/d.5

Table J-2b
TWO-SIDED p-VALUES FOR NONPARAMETRIC MULTIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS[a,b]

Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
	1	2	3	4	5	6	7	221	225	C&T
1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	1.000	0.613	0.001	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.613	1.000	0.004	0.000	0.000	0.000	0.000	0.022	0.000
4	0.000	0.001	0.004	1.000	0.084	0.086	0.009	0.000	0.095	0.000
5	0.000	0.000	0.000	0.084	1.000	0.220	0.028	0.037	0.023	0.000
6	0.000	0.000	0.000	0.086	0.220	1.000	0.008	0.001	0.019	0.000
7	0.000	0.000	0.000	0.009	0.028	0.008	1.000	0.004	0.778	0.000
221	0.000	0.000	0.000	0.000	0.037	0.001	0.004	1.000	0.017	0.000
225	0.000	0.002	0.022	0.095	0.023	0.019	0.778	0.017	1.000	0.000
C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

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a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

Table J-3

RESULTS FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH OBSERVATIONS LESS THAN OR EQUAL TO 2.0 ppb TREATED AS NONDETECT[a,b,c,d,e,f]

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DCB	1	ND		-(--)	--	--	--	--	--	--	--	--
	2	ND	+(++)		o	o(--)	o	o	o	o	o	o(--)
	3	ND	++	o		o(--)	o	o(-)	o	o	o	o(--)
	4	ND	++	o(++)	o(++)		o(+)	o	o(++)	o(++)	o(+)	o
	5	ND	++	o	o	o(-)		o(-)	o	o	o	o
	6	ND	++	o	o(+)	o	o(+)		o(+)	o(++)	o	o
	7	ND	++	o	o	o(--)	o	o(-)		o	o	o(-)
	221	ND	++	o	o	o(--)	o	o(--)	o		o	o(--)
	225	ND	++	o	o	o(-)	o	o	o	o		o
	C&T	ND	++	o(++)	o(++)	o	o	o	o(+)	o(++)	o	
			8.67	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCB	1	8.67		--	--	--	--	--	--	--	--	--
	2	ND	++		o	o(--)	o(--)	--	-(--)	-(--)	o(--)	--
	3	ND	++	o		o(--)	o(-)	--	o(--)	o(-)	o(-)	--
	4	ND	++	o(++)	o(++)		o	-(o)	o	o(+)	o	-(--)
	5	ND	++	o(++)	o(+)	o		--	-(o)	-(o)	o	--
	6	ND	++	++	++	o(o)	++		o(++)	o(++)	++	o(--)
	7	ND	++	+(++)	o(++)	o	+(o)	o(--)		o	+(o)	o(--)
	221	ND	++	+(++)	o(+)	o(-)	+(o)	o(--)	o		+(o)	o(--)
	225	ND	++	o(++)	o(+)	o	o	--	-(o)	-(o)		--
	C&T	ND	++	++	++	+(++)	++	o(++)	o(++)	o(++)	++	

Table J-3
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas 1	2	3	4	5	6	7	Comparison Areas 221	225	C&T
			11.48	ND	ND	ND	ND	ND	ND	ND	ND	ND
TeCB	1	11.48		--	--	--	--	--	--	--	--	--
	2	ND	++		o	--	-(--)	--	--	--	o(--)	--
	3	ND	++	o		o(--)	o(--)	--	--	--	o(--)	--
	4	ND	++	++	o(++)		o	--(o)	o	-(+)	o	--
	5	ND	++	+(++)	o(++)	o		--	o	--(o)	o	--
	6	ND	++	++	++	++(o)	++		o(++)	o(++)	++	o(--)
	7	ND	++	++	++	o	o	o(--)		o	+(o)	o(--)
	221	ND	++	++	++	+(-)	++(o)	o(--)	o		++(o)	o(--)
	225	ND	++	o(++)	o(++)	o	o	--	-(o)	--(o)		--
	C&T	ND	++	++	++	++	++	o(++)	o(++)	o(++)	++	
			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CNP	1	ND		o	o	o	o	o	o	o	o(+)	o
	2	ND	o		o	o	o	o	o	o	o(+)	o
	3	ND	o	o		o	o	o	o(+)	o	o(++)	o
	4	ND	o	o	o		o	o	o	o	o	o
	5	ND	o	o	o	o		o	o	o	o(+)	o
	6	ND	o	o	o	o	o		o	o	o	o
	7	ND	o	o	o(-)	o	o	o		o	o	o(-)
	221	ND	o	o	o	o	o	o	o		o	o
	225	ND	o(-)	o(-)	o(--)	o	o(-)	o	o	o		o(-)
	C&T	ND	o	o	o	o	o	o	o(+)	o	o(+)	

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Table J-3
(continued)

ICIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas 1	2	3	4	5	6	7	Comparison Areas 221	225	C&T
			8.25	ND	ND	ND	ND	ND	ND	ND	ND	ND
a-BHC	1	8.25		--	--	--	--	--	--	--	--	--
	2	ND	++		o(-)	o(--)	o(--)	--	-(--)	-(--)	o(--)	-(--)
	3	ND	++	o(+)		o	o(-)	-(--)	o(-)	o	o	-(--)
	4	ND	++	o(++)	o		o	--(o)	--(o)	-(o)	o	--
	5	ND	++	o(++)	o(+)	o		--(o)	-(o)	-(o)	o	-(--)
	6	ND	++	++	+(++)	++(o)	++(o)		o(+)	o(+)	++(o)	o(--)
	7	ND	++	+(++)	o(+)	++(o)	+(o)	o(-)		o	+(o)	o(--)
	221	ND	++	+(++)	o	+(o)	+(o)	o(-)	o		+(o)	o(--)
	225	ND	++	o(++)	o	o	o	--(o)	-(o)	-(o)		-(--)
	C&T	ND	++	+(++)	+(++)	++	+(++)	o(++)	o(++)	o(++)	+(++)	
			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	1	ND		--	--	--	--	--	--	--	--	--
	2	ND	++		o(-)	o(--)	o(--)	o(--)	o(--)	o(--)	o(--)	o(--)
	3	ND	++	o(+)		o	o	o(--)	o(--)	o(--)	o	o(--)
	4	ND	++	o(++)	o		o	o	o	o(-)	o	o(--)
	5	ND	++	o(++)	o	o		o(-)	o	o(-)	o	o(--)
	6	ND	++	o(++)	o(++)	o	o(+)		o	o	o	o(--)
	7	ND	++	o(++)	o(++)	o	o	o		o	o	o(--)
	221	ND	++	o(++)	o(++)	o(+)	o(+)	o	o		o	o
	225	ND	++	o(++)	o	o	o	o	o	o		o(--)
	C&T	ND	++	o(++)	o(++)	o(++)	o(++)	o(++)	o(++)	o	o(++)	

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Table J-3
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			11.58	ND	ND	ND	ND	ND	ND	ND	ND	ND
b-BHC	1	11.58		--	--	--	--	--	--	--	--	--
	2	ND	++		o	o	o(--)	-(--)	-(--)	-(--)	o	o(--)
	3	ND	++	o		o	o(-)	-(--)	-(o)	-(--)	o	-(--)
	4	ND	++	o	o		o	--	--(o)	--(-)	o	-(--)
	5	ND	++	o(++)	o(+)	o		-(o)	o	-(o)	o	o(--)
	6	ND	++	+(++)	+(++)	++	+(o)		o(++)	o	o(++)	o(--)
	7	ND	++	+(++)	+(o)	++(o)	o	o(--)		o	o	o(--)
	221	ND	++	+(++)	+(++)	++(+)	+(o)	o	o		+	o(--)
	225	ND	++	o	o	o	o	o(--)	o	-		o(--)
	C&T	ND	++	o(++)	+(++)	+(++)	o(++)	o(++)	o(++)	o(++)	o(++)	
			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC	1	ND		--	--	--	--	--	--	--	--	--
	2	ND	++		o	o(-)	o(--)	o(--)	o(--)	o(--)	o(-)	o(--)
	3	ND	++	o		o	o(-)	-(--)	o(--)	o(--)	o	o(--)
	4	ND	++	o(+)	o		o	--(-)	--(o)	o(-)	o	o(--)
	5	ND	++	o(++)	o(+)	o		-(o)	-(o)	o	o	-(--)
	6	ND	++	o(++)	+(++)	++(+)	+(o)		o	o	+(+)	o(--)
	7	ND	++	o(++)	o(++)	++(o)	+(o)	o		o	o	o(--)
	221	ND	++	o(++)	o(++)	o(+)	o	o	o		o	o(--)
	225	ND	++	o(+)	o	o	o	o(-)	o	o		o(--)
	C&T	ND	++	o(++)	o(++)	o(++)	+(++)	o(++)	o(++)	o(++)	o(++)	

Table J-3
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
TOTALS	++		62	8	6	8	6	0	0	0	6	0
	+		1	8	6	5	7	0	0	0	4	0
	o		9	51	54	52	52	47	53	49	56	49
	-		0	1	0	0	1	5	9	12	0	7
	--		0	4	6	7	6	20	10	11	6	16
All Symbols			72	72	72	72	72	72	72	72	72	72

---

a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. The first entry in each column is median concentration. ND indicates nondetect.

d. C&T denotes Cheektowaga and Tonawanda.

e. Based on observations classified as Good.

f. Any change in results between this table and the original comparisons reported in Table STM2-1a is indicated by two sets of symbols; the second set of symbols denotes the original results.

Table J-4a

RESULTS FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH UPPER 10 PERCENT TRIMMED IN EACH AREA^{a,b,c,d,e,f}

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas 1	2	3	4	5	6	7	Comparison Areas 221	225	C&T
			0.94	0.35	0.39	0.33	0.36	0.33	0.38	0.38	0.39	0.35
DCB	1	0.94		--	--	--	--	--	--	--	--	--
	2	0.35	++		o	--	o	o	o	o	o	--
	3	0.39	++	o		--	o	o	o	o	o	--
	4	0.33	++	++	++		o(+)	o	++	++	+	o
	5	0.36	++	o	o	o(-)		o(-)	o	o	o	o
	6	0.33	++	o	o	o	o(+)		+	++	o	o
	7	0.38	++	o	o	--	o	-		o	o	--(-)
	221	0.38	++	o	o	--	o	--	o		o	--
	225	0.39	++	o	o	-	o	o	o	o		o
	C&T	0.35	++	++	++	o	o	o	++(+)	++	o	
			7.80	0.83	0.79	0.41	0.44	0.36	0.54	0.63	0.56	0.13
TCB	1	7.80		--	--	--	--	--	--	--	--	--
	2	0.83	++		o	--	--	--	--	--	--	--
	3	0.79	++	o		--	--(-)	--	--	-	--(-)	--
	4	0.41	++	++	++		o	o	+(o)	++(+)	o	--
	5	0.44	++	++	++(+)	o		--	o	o	o	--
	6	0.36	++	++	++	o	++		++	++	++	--
	7	0.54	++	++	++	-(o)	o	--		o	o	--
	221	0.63	++	++	+	--(-)	o	--	o		o	--
	225	0.56	++	++	++(+)	o	o	--	o	o		--
	C&T	0.13	++	++	++	++	++	++	++	++	++	
			11.34	1.09	0.94	0.35	0.38	0.28	0.49	0.50	0.54	0.05
TeCB	1	11.34		--	--	--	--	--	--	--	--	--
	2	1.09	++		-(o)	--	--	--	--	--	--	--
	3	0.94	++	+(o)		--	--	--	--	--	--	--
	4	0.35	++	++	++		o	o	+(o)	++(+)	+(+)	--
	5	0.38	++	++	++	o		--	o	o	o	--
	6	0.28	++	++	++	o	++		++	++	++	--
	7	0.49	++	++	++	-(o)	o	--		o	o	--
	221	0.50	++	++	++	--(-)	o	--	o		o	--
	225	0.54	++	++	++	-(o)	o	--	o	o		--
	C&T	0.05	++	++	++	++	++	++	++	++	++	

Table J-4a
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			ND	0.04	ND	0.04	0.05	0.05	0.05	0.05	0.07	0.02
CNP	1	ND		o	o	o	o	+(o)	o	+(o)	+	o
	2	0.04	o		o	o	o	+(o)	+(o)	+(o)	++(+)	o
	3	ND	o	o		o	o	o	+	+(o)	++	o
	4	0.04	o	o	o		o	o	o	o	o	o
	5	0.05	o	o	o	o		o	o	o	+	o
	6	0.05	-(o)	-(o)	o	o	o		o	o	o	o
	7	0.05	o	-(o)	-	o	o	o		o	o	-
	221	0.05	-(o)	-(o)	-(o)	o	o	o	o		o	o
	225	0.07	-	--(-)	--	o	-	o	o	o		--(-)
	C&T	0.02	o	o	o	o	o	o	+	o	++(+)	
			7.51	0.35	0.18	0.08	0.06	0.06	0.13	0.18	0.07	ND
a-BHC	1	7.51		--	--	--	--	--	--	--	--	--
	2	0.35	++		--(-)	--	--	--	--	--	--	--
	3	0.18	++	++(+)		o	-	--	-	o	o	--
	4	0.08	++	++	o		o	o	o	o	o	--
	5	0.06	++	++	+	o		o	o	o	o	--
	6	0.06	++	++	++	o	o		+	++(+)	o	--
	7	0.13	++	++	+	o	o	-		o	o	--
	221	0.18	++	++	o	o	o	--(-)	o		o	--
	225	0.07	++	++	o	o	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
			0.79	ND	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	1	0.79		--	--	--	--	--	--	--	--	--
	2	ND	++		--(-)	--	--	--	--	--	--	--
	3	ND	++	++(+)		-(o)	o	--	--	--	-(o)	--
	4	ND	++	++	+(o)		o	-(o)	o	-	o	--
	5	ND	++	++	o	o		--(-)	-(o)	--(-)	o	--
	6	ND	++	++	++	+(o)	++(+)		o	o	o	o(--)
	7	ND	++	++	++	o	+(o)	o		o	o	o(--)
	221	ND	++	++	++	+	++(+)	o	o		o	o
	225	ND	++	++	+(+)	o	o	o	o	o		-(--)
	C&T	ND	++	++	++	++	++	o(++)	o(++)	o	+(++)	
			10.73	0.17	ND	ND	ND	ND	ND	ND	ND	ND
b-BHC	1	10.73		--	--	--	--	--	--	--	--	--
	2	0.17	++		o	o	--	--	--	--	o	--
	3	ND	++	o		o	--(-)	--	o	--	o	--
	4	ND	++	o	o		-(o)	--	o	-	o	--
	5	ND	++	++	++(+)	+(o)		o	o	o	+(o)	--
	6	ND	++	++	++	++	o		++	o	++	--
	7	ND	++	++	o	o	o	--		-(o)	o	--
	221	ND	++	++	++	+	o	o	+(o)		+	--
	225	ND	++	o	o	o	-(o)	--	o	-		--
	C&T	ND	++	++	++	++	++	++	++	++	++	

Table J-4a
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			1.48	0.03	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC	1	1.48		--	--	--	--	--	--	--	--	--
	2	0.03	++		o	--(-)	--	--	--	--	--(-)	--
	3	ND	++	o		o	--(-)	--	--	--	o	--
	4	ND	++	++(+)	o		o	--(-)	o	-	o	--
	5	ND	++	++	++(+)	o		o	o	o	o	--
	6	ND	++	++	++	++(+)	o		o	o	++(+)	-(-)
	7	ND	++	++	++	o	o	o		o	o	--
	221	ND	++	++	++	+	o	o	o		o	-(-)
	225	ND	++	++(+)	o	o	o	--(-)	o	o		--
	C&T	ND	++	++	++	++	++	+(++)	++	+(++)	++	
TOTALS	++		63	44	30	8	10	4	10	12	12	0
	+		0	1	5	5	1	3	8	4	7	0
	o		6	16	24	34	40	27	35	32	38	14
	-		3	3	3	5	4	3	2	6	1	4
	--		0	8	10	20	17	35	17	18	14	54
All Symbols			72	72	72	72	72	72	72	72	72	72

---

a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
 + = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
 o = No significant difference at 0.05 significance level.
 - = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
 -- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. The first entry in each column is median concentration; ND indicates non-detect.

d. C&T = Cheektowaga and Tonawanda.

e. Based on observations classified as Good.

f. Any change in results between Table STMS2-1a and this table is indicated by two sets of symbols; the second set of symbols denotes the original results reported in Table STM2-1a.

WDR357/d.7/3

Table J-4b

TWO-SIDED p-VALUES FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH UPPER 10 PERCENT TRIMMED IN EACH AREA[a,b]

LCIC	Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
DCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.854	0.008	0.427	0.092	0.901	0.861	0.711	0.005
	3	0.000	0.854	1.000	0.005	0.558	0.063	0.949	0.918	0.560	0.002
	4	0.000	0.008	0.005	1.000	0.060	0.292	0.001	0.003	0.018	0.894
	5	0.000	0.427	0.558	0.060	1.000	0.077	0.373	0.405	0.914	0.073
	6	0.000	0.092	0.063	0.292	0.077	1.000	0.030	0.009	0.328	0.158
	7	0.000	0.901	0.949	0.001	0.373	0.030	1.000	0.932	0.554	0.008
	221	0.000	0.861	0.918	0.003	0.405	0.009	0.932	1.000	0.817	0.002
	225	0.000	0.711	0.560	0.018	0.914	0.328	0.554	0.817	1.000	0.111
	C&T	0.000	0.005	0.002	0.894	0.073	0.158	0.008	0.002	0.111	1.000
TCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.233	0.000	0.000	0.000	0.000	0.003	0.003	0.000
	3	0.000	0.233	1.000	0.000	0.009	0.000	0.000	0.016	0.006	0.000
	4	0.000	0.000	0.000	1.000	0.134	0.218	0.035	0.002	0.059	0.000
	5	0.000	0.000	0.009	0.134	1.000	0.003	0.677	0.072	0.771	0.000
	6	0.000	0.000	0.000	0.218	0.003	1.000	0.000	0.000	0.006	0.000
	7	0.000	0.000	0.000	0.035	0.677	0.000	1.000	0.052	0.637	0.000
	221	0.000	0.003	0.016	0.002	0.072	0.000	0.052	1.000	0.180	0.000
	225	0.000	0.003	0.006	0.059	0.771	0.006	0.637	0.180	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
TeCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.046	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.000	0.000	0.000	1.000	0.468	0.117	0.020	0.007	0.030	0.000
	5	0.000	0.000	0.000	0.468	1.000	0.007	0.090	0.142	0.164	0.000
	6	0.000	0.000	0.000	0.117	0.007	1.000	0.000	0.000	0.000	0.000
	7	0.000	0.000	0.000	0.020	0.090	0.000	1.000	0.765	0.790	0.000
	221	0.000	0.000	0.000	0.007	0.142	0.000	0.765	1.000	0.568	0.000
	225	0.000	0.000	0.000	0.030	0.164	0.000	0.790	0.568	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
CNP	1	1.000	0.698	0.516	0.171	0.218	0.046	0.055	0.035	0.016	0.440
	2	0.698	1.000	0.792	0.614	0.343	0.038	0.032	0.018	0.003	0.935
	3	0.516	0.792	1.000	0.312	0.654	0.160	0.022	0.049	0.007	0.704
	4	0.171	0.614	0.312	1.000	0.771	0.800	0.279	0.572	0.069	0.099
	5	0.218	0.343	0.654	0.771	1.000	0.244	0.141	0.299	0.010	0.551
	6	0.046	0.038	0.160	0.800	0.244	1.000	0.379	0.382	0.238	0.139
	7	0.055	0.032	0.022	0.279	0.141	0.379	1.000	0.955	0.532	0.017
	221	0.035	0.018	0.049	0.572	0.299	0.382	0.955	1.000	0.810	0.064
	225	0.016	0.003	0.007	0.069	0.010	0.238	0.532	0.810	1.000	0.004
	C&T	0.440	0.935	0.704	0.099	0.551	0.139	0.017	0.064	0.004	1.000
a-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.003	1.000	0.239	0.014	0.000	0.026	0.122	0.098	0.000
	4	0.000	0.000	0.239	1.000	0.585	0.113	0.724	0.931	0.352	0.000
	5	0.000	0.000	0.014	0.585	1.000	0.189	0.337	0.087	0.895	0.000
	6	0.000	0.000	0.000	0.113	0.189	1.000	0.011	0.006	0.276	0.000
	7	0.000	0.000	0.026	0.724	0.337	0.011	1.000	0.321	0.394	0.000
	221	0.000	0.000	0.122	0.931	0.087	0.006	0.321	1.000	0.116	0.000
	225	0.000	0.000	0.098	0.352	0.895	0.276	0.394	0.116	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Table J-4b
(continued)

LCIC	Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
d-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.002	1.000	0.047	0.118	0.000	0.001	0.001	0.026	0.000
	4	0.000	0.000	0.047	1.000	0.714	0.021	0.111	0.024	0.329	0.009
	5	0.000	0.000	0.118	0.714	1.000	0.002	0.040	0.004	0.355	0.003
	6	0.000	0.000	0.000	0.021	0.002	1.000	0.284	0.371	0.105	0.371
	7	0.000	0.000	0.001	0.111	0.040	0.284	1.000	0.148	0.572	0.090
	221	0.000	0.000	0.001	0.024	0.004	0.371	0.148	1.000	0.069	1.000
	225	0.000	0.000	0.026	0.329	0.355	0.105	0.572	0.069	1.000	0.045
	C&T	0.000	0.000	0.000	0.009	0.003	0.371	0.090	1.000	0.045	1.000
b-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.249	0.074	0.000	0.000	0.001	0.000	0.051	0.000
	3	0.000	0.249	1.000	0.358	0.002	0.000	0.082	0.001	0.417	0.000
	4	0.000	0.074	0.358	1.000	0.018	0.000	0.693	0.027	0.776	0.000
	5	0.000	0.000	0.002	0.018	1.000	0.055	0.088	0.673	0.025	0.000
	6	0.000	0.000	0.000	0.000	0.055	1.000	0.000	0.139	0.000	0.008
	7	0.000	0.001	0.082	0.693	0.088	0.000	1.000	0.026	0.601	0.000
	221	0.000	0.000	0.001	0.027	0.673	0.139	0.026	1.000	0.035	0.000
	225	0.000	0.051	0.417	0.776	0.025	0.000	0.601	0.035	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	1.000
g-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.244	0.007	0.000	0.000	0.000	0.000	0.003	0.000
	3	0.000	0.244	1.000	0.148	0.005	0.000	0.000	0.000	0.082	0.000
	4	0.000	0.007	0.148	1.000	0.304	0.004	0.068	0.016	0.705	0.000
	5	0.000	0.000	0.005	0.304	1.000	0.061	0.471	0.148	0.306	0.001
	6	0.000	0.000	0.000	0.004	0.061	1.000	0.195	0.837	0.008	0.036
	7	0.000	0.000	0.000	0.068	0.471	0.195	1.000	0.307	0.105	0.002
	221	0.000	0.000	0.000	0.016	0.148	0.837	0.307	1.000	0.088	0.030
	225	0.000	0.003	0.082	0.705	0.306	0.008	0.105	0.088	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.001	0.036	0.002	0.030	0.000	1.000

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a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

Table J-4c

SUMMARY OF NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH UPPER 10 PERCENT TRIMMED IN EACH AREA[a,b,c,d]

Sampling/ Comparison Area		Totals Over all LCICs									
		EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
1	++		0	0	0	0	0	0	0	0	0
	+		0	0	0	0	1	0	1	1	0
	o		1	1	1	1	0	1	0	0	1
	-		0	0	0	0	0	0	0	0	0
	--		7	7	7	7	7	7	7	7	7
2	++	7		0	0	0	0	0	0	1	0
	+	0		0	0	0	1	1	1	0	0
	o	1		5	2	2	1	1	1	2	1
	-	0		1	0	0	0	0	0	0	0
	--	0		2	6	6	6	6	6	5	7
3	++	7	2		0	0	0	0	0	1	0
	+	0	1		0	0	0	1	1	0	0
	o	1	5		4	3	2	2	2	4	1
	-	0	0		1	1	0	1	1	1	0
	--	0	0		3	4	6	4	4	2	7
4	++	7	5	3		0	0	1	3	0	0
	+	0	0	1		0	0	2	0	2	0
	o	1	3	4		7	5	5	2	6	2
	-	0	0	0		1	1	0	3	0	0
	--	0	0	0		0	2	0	0	0	6
5	++	7	6	4	0		0	0	0	0	0
	+	0	0	1	1		0	0	0	2	0
	o	1	2	3	7		5	7	7	6	2
	-	0	0	0	0		0	1	0	0	0
	--	0	0	0	0		3	0	1	0	6
6	++	7	6	6	2	3		3	4	4	0
	+	0	0	0	1	0		2	0	0	0
	o	0	1	2	5	5		3	4	4	3
	-	1	1	0	0	0		0	0	0	1
	--	0	0	0	0	0		0	0	0	4

Table J-4c
(Continued)

Sampling/ Comparison Area		Totals Over All LCICs									
		EDA Sampliing Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
7	++	7	6	4	0	0	0		0	0	0
	+	0	0	1	0	1	0		0	0	0
	o	1	1	2	5	7	3		7	8	1
	-	0	1	1	2	0	2		1	0	1
	--	0	0	0	1	0	3		0	0	6
221	++	7	6	4	0	1	0	0		0	0
	+	0	0	1	3	0	0	1		1	0
	o	0	1	2	1	7	5	7		7	2
	-	1	1	1	0	0	0	0		0	1
	--	0	0	0	4	0	3	0		0	5
225	++	7	5	2	0	0	0	0	0		0
	+	0	0	1	0	0	0	0	0		0
	o	0	2	4	6	6	4	8	7		1
	-	1	0	0	2	2	0	0	1		1
	--	0	1	1	0	0	4	0	0		6
C&T	++	7	7	7	6	6	4	6	5	6	
	+	0	0	0	0	0	1	1	1	1	
	o	1	1	1	2	2	3	1	2	1	
	-	0	0	0	0	0	0	0	0	0	
	--	0	0	0	0	0	0	0	0	0	

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a. ++ = Colummn sampling/comparison area < Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.

b. All tests results reported are based on two-sided p-values.

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

Table J-5

COUNTS OF SAMPLES VERSUS FAILED LCIC IDENTIFICATIONS CAUSED BY ION RATIOS IN THE RANGE OF +/- 20 TO 40 PERCENT OF THE THEORETICAL RATIO[a]

SOIL ASSESSMENT--INDICATOR CHEMICALS

	LCIC							
Category	DCB	TCB	TeCB	CNP	A-BHC	D-BHC	B-BHC	G-BHC
Detect[b]	649	684	658	399	464	152	268	215
20% to 40%[c]	0	0	2	55	63	32	53	31
>40%[d]	2	0	2	23	49	64	75	52
Other NDs[e]	4	1	14	163	109	425	238	383
Flagged as U/B[f]	126	96	105	141	96	108	147	100
Total	781	781	781	781	781	781	781	781
Percent Increase in Detects Using 20% to 40% Ion Ratios	0.0	0.0	0.3	13.8	13.6	21.0	19.8	14.4

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[a] Only Good data included in this table

[b] Passed all ID criteria

[c] Failed only the ion ratio criteria in the +/- 20% to 40% theoretical range

[d] Failed only the ion ratio criteria in >40% theoretical range

[e] Failed ID criteria other than only the ion ratio

[f] Failed the EMSL/LV data usability review as Uncertain or Bad data

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Table J-6a

RESULTS FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS BASED ON ION RATIO-MODIFIED CONCENTRATIONS[a,b,c,d,e,f]

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Ares							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			1.01	0.39	0.40	0.36	0.39	0.36	0.41	0.39	0.43	0.36
DCB	1	1.01		--	--	--	--	--	--	--	--	--
	2	0.39	++		o	--	o	o	o	o	o	--
	3	0.40	++	o		--	o	-	o	o	o	--
	4	0.36	++	++	++		+	o	++	++	+	o
	5	0.39	++	o	o	-		o(-)	o	o	o	o
	6	0.36	++	o	+	o	o(+)		+	++	o	o
	7	0.41	++	o	o	--	o	-		o	o	-
	221	0.39	++	o	o	--	o	--	o		o	--
	225	0.43	++	o	o	-	o	o	o	o		o
	C&T	0.36	++	++	++	o	o	o	+	++	o	
			8.67	0.91	0.89	0.44	0.50	0.37	0.58	0.65	0.60	0.13
TCB	1	8.67		--	--	--	--	--	--	--	--	--
	2	0.91	++		o	--	--	--	--	--	--	--
	3	0.89	++	o		--	-	--	--	-	-	--
	4	0.44	++	++	++		o	o	o	+	o	--
	5	0.50	++	++	+	o		--	o	o	o	--
	6	0.37	++	++	++	o	++		++	++	++	--
	7	0.58	++	++	++	o	o	--		o	o	--
	221	0.65	++	++	+	-	o	--	o		o	--
	225	0.60	++	++	+	o	o	--	o	o		--
	C&T	0.13	++	++	++	++	++	++	++	++	++	
			11.48	1.17	1.06	0.39	0.43	0.31	0.54	0.53	0.61	0.05
TeCB	1	11.48		--	--	--	--	--	--	--	--	--
	2	1.17	++		o	--	--	--	--	--	--	--
	3	1.06	++	o		--	--	--	--	--	--	--
	4	0.39	++	++	++		o	o	o	o	o	--
	5	0.43	++	++	++	o		--	o	o	o	--
	6	0.31	++	++	++	o	++		++	++	++	--
	7	0.54	++	++	++	o	o	--		o	o	--
	221	0.53	++	++	++	o	o	--	o		o	--
	225	0.61	++	++	++	o	o	--	o	o		--
	C&T	0.05	++	++	++	++	++	++	++	++	++	

J-29

Table J-6a
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas 1	2	3	4	5	6	7	Comparison Areas 221	225	C&T
			0.06	0.05	0.05	0.04	0.06	0.07	0.06	0.07	0.07	0.04
CNP	1	0.06		o	o	o	o	o	o	o	o(+)	o
	2	0.05	o		o	o	o	o	o	+(o)	o(+)	o
	3	0.05	o	o		o	o	o	++(+)	+(o)	++	o
	4	0.04	o	o	o		o	o	+(o)	o	+(+)	o
	5	0.06	o	o	o	o		o	o	o	+	o
	6	0.07	o	o	o	o	o		o	o	o	o
	7	0.06	o	o	--(-)	-(o)	o	o		o	o	--(-)
	221	0.07	o	-(o)	-(o)	o	o	o	o		o	-(o)
	225	0.07	o(-)	o(-)	--	-(o)	-	o	o	o		-
	C&T	0.04	o	o	o	o	o	o	++(+)	+(o)	+	
			8.25	0.40	0.24	0.13	0.14	0.10	0.17	0.18	0.15	ND
a-BHC	1	8.25		--	--	--	--	--	--	--	--	--
	2	0.40	++		--(-)	--	--	--	--	--	--	--
	3	0.24	++	++(+)		o	-	--	o(-)	-(o)	o	--
	4	0.13	++	++	o		o	-(o)	o	o	o	--
	5	0.14	++	++	+	o		o	o	o	o	--
	6	0.10	++	++	++	+(o)	o		++(+)	++(+)	+(o)	--
	7	0.17	++	++	o(+)	o	o	--(-)		o	o	--
	221	0.18	++	++	+(o)	o	o	--(-)	o		o	--
	225	0.15	++	++	o	o	o	-(o)	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
			1.39	0.10	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	1	1.39		--	--	--	--	--	--	--	--	--
	2	0.10	++		-	--	--	--	--	--	--	--
	3	ND	++	+		o	o	--	--	--	o	--
	4	ND	++	++	o		o	-(o)	o	-	o	--
	5	ND	++	++	o	o		-	o	-	o	--
	6	ND	++	++	++	+(o)	+		o	o	o	--
	7	ND	++	++	++	o	o	o		o	o	--
	221	ND	++	++	++	+	+	o	o		o	-(o)
	225	ND	++	++	o	o	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	+(o)	++	

Table J-6a
(continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2	3	4	5	6	7	221	225	C&T
			11.58	0.29	0.15	0.07	ND	ND	0.10	ND	0.12	ND
b-BHC	1	11.58		--	--	--	--	--	--	--	--	--
	2	0.29	++		o	-(o)	--	--	--	--	o	--
	3	0.15	++	o		o	o(-)	--	o	--	o	--
	4	0.07	++	+(o)	o		o	--	o	-	o	--
	5	ND	++	++	o(+)	o		-(o)	o	o	o	--
	6	ND	++	++	++	++	+(o)		++	o	++	--
	7	0.10	++	++	o	o	o	--		-(o)	o	--
	221	ND	++	++	++	+	o	o	+(+)		+	--
	225	0.12	++	o	o	o	o	--	o	-		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
			1.48	0.09	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC	1	1.48		--	--	--	--	--	--	--	--	--
	2	0.09	++		o	-	--	--	--	--	--(-)	--
	3	ND	++	o		o	-	--	--	--	o	--
	4	ND	++	+	o		o	--(-)	o	o(-)	o	--
	5	ND	++	++	+	o		o	o	o	o	--
	6	ND	++	++	++	++(+)	o		o	o	o(+)	--
	7	ND	++	++	++	o	o	o		o	o	--
	221	ND	++	++	++	o(+)	o	o	o		o	--
	225	ND	++	++(+)	o	o	o	o(-)	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	

Table J-6a
(continued)

TOTALS	++	63	42	26	8	8	6	13	11	10	0
	+	0	3	7	4	4	0	4	5	6	0
	o	9	19	27	36	42	25	38	32	42	10
	-	0	1	2	7	4	7	0	7	1	4
	--	0	7	10	17	14	34	17	17	13	58
All Symbols		72	72	72	72	72	72	72	72	72	72

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a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. The first entry in each column is median concentration, ND indicates nondetect.

d. 221=Census Tract 221.
225=Census Tract 225.
C&T=Cheektowaga and Tonawanda.

e. Based on observations classified as Good.

f. Any change in results between Table STMS2-1a and this table is indicated by two sets of symbols; the second set of symbols denotes the original results, reported in Table STM2-1a.

Table J-6b

TWO-SIDED p-VALUES FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS BASED ON ION RATIO-MODIFIED CONCENTRATIONS^{a,b}

		EDA Sampling Areas							Comparison Areas		
LCIC	Sampling/ Comparison Area	1	2	3	4	5	6	7	221	225	C&T
DCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.989	0.004	0.397	0.052	0.564	0.805	0.539	0.008
	3	0.000	0.989	1.000	0.006	0.644	0.041	0.740	0.980	0.583	0.002
	4	0.000	0.004	0.006	1.000	0.030	0.361	0.003	0.004	0.026	0.896
	5	0.000	0.397	0.644	0.030	1.000	0.050	0.588	0.534	0.817	0.057
	6	0.000	0.052	0.041	0.361	0.050	1.000	0.035	0.009	0.312	0.146
	7	0.000	0.564	0.740	0.003	0.588	0.035	1.000	0.992	0.556	0.022
	221	0.000	0.805	0.980	0.004	0.534	0.009	0.992	1.000	0.757	0.007
	225	0.000	0.539	0.583	0.026	0.817	0.312	0.556	0.757	1.000	0.194
	C&T	0.000	0.008	0.002	0.896	0.057	0.146	0.022	0.007	0.194	1.000
TCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.245	0.000	0.001	0.000	0.000	0.001	0.010	0.000
	3	0.000	0.245	1.000	0.000	0.029	0.000	0.002	0.014	0.032	0.000
	4	0.000	0.000	0.000	1.000	0.221	0.185	0.112	0.015	0.092	0.000
	5	0.000	0.001	0.029	0.221	1.000	0.002	0.855	0.208	0.750	0.000
	6	0.000	0.000	0.000	0.185	0.002	1.000	0.000	0.000	0.005	0.000
	7	0.000	0.000	0.002	0.112	0.855	0.000	1.000	0.123	0.808	0.000
	221	0.000	0.001	0.014	0.015	0.208	0.000	0.123	1.000	0.368	0.000
	225	0.000	0.010	0.032	0.092	0.750	0.005	0.808	0.368	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
TeCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.069	1.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000
	4	0.000	0.000	0.000	1.000	0.562	0.102	0.071	0.054	0.064	0.000
	5	0.000	0.000	0.000	0.562	1.000	0.009	0.184	0.360	0.214	0.000
	6	0.000	0.000	0.000	0.102	0.009	1.000	0.000	0.000	0.000	0.000
	7	0.000	0.000	0.000	0.071	0.184	0.000	1.000	0.446	0.982	0.000
	221	0.000	0.000	0.000	0.054	0.360	0.000	0.446	1.000	0.346	0.000
	225	0.000	0.000	0.005	0.064	0.214	0.000	0.982	0.346	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
CNP	1	1.000	0.445	0.693	0.843	0.910	0.557	0.361	0.320	0.202	0.946
	2	0.445	1.000	0.885	0.517	0.428	0.254	0.074	0.019	0.057	0.573
	3	0.693	0.885	1.000	0.638	0.566	0.346	0.008	0.024	0.009	0.559
	4	0.843	0.517	0.638	1.000	0.524	0.365	0.012	0.112	0.045	0.398
	5	0.910	0.428	0.566	0.524	1.000	0.405	0.083	0.186	0.036	0.329
	6	0.557	0.254	0.346	0.365	0.405	1.000	0.093	0.120	0.332	0.230
	7	0.361	0.074	0.008	0.012	0.083	0.093	1.000	0.995	0.643	0.002
	221	0.320	0.019	0.024	0.112	0.186	0.120	0.995	1.000	0.726	0.026
	225	0.202	0.057	0.009	0.045	0.036	0.332	0.643	0.726	1.000	0.018
	C&T	0.946	0.573	0.559	0.398	0.329	0.230	0.002	0.026	0.018	1.000
a-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.010	0.001	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.010	1.000	0.263	0.019	0.000	0.051	0.045	0.219	0.000
	4	0.000	0.001	0.263	1.000	0.312	0.028	0.736	0.785	0.868	0.000
	5	0.000	0.000	0.019	0.312	1.000	0.219	0.146	0.190	0.425	0.000
	6	0.000	0.000	0.000	0.028	0.219	1.000	0.001	0.009	0.035	0.000
	7	0.000	0.000	0.051	0.736	0.146	0.001	1.000	0.808	0.392	0.000
	221	0.000	0.000	0.045	0.785	0.190	0.009	0.808	1.000	0.698	0.000
	225	0.000	0.000	0.219	0.868	0.425	0.035	0.392	0.698	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Table J-6b
(continued)

LCIC	Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
		1	2	3	4	5	6	7	221	225	C&T
d-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.029	0.004	0.000	0.000	0.000	0.000	0.000	0.000
	3	0.000	0.029	1.000	0.151	0.202	0.000	0.001	0.000	0.117	0.000
	4	0.000	0.004	0.151	1.000	0.725	0.022	0.118	0.018	0.216	0.000
	5	0.000	0.000	0.202	0.725	1.000	0.032	0.124	0.019	0.490	0.000
	6	0.000	0.000	0.000	0.022	0.032	1.000	0.522	0.629	0.368	0.002
	7	0.000	0.000	0.001	0.118	0.124	0.522	1.000	0.264	0.667	0.000
	221	0.000	0.000	0.000	0.018	0.019	0.629	0.264	1.000	0.111	0.023
	225	0.000	0.000	0.117	0.216	0.490	0.368	0.667	0.111	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.023	0.000	1.000
b-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.185	0.050	0.001	0.000	0.001	0.000	0.117	0.000
	3	0.000	0.185	1.000	0.224	0.100	0.000	0.239	0.000	0.589	0.000
	4	0.000	0.050	0.224	1.000	0.488	0.001	0.969	0.048	0.710	0.000
	5	0.000	0.001	0.100	0.488	1.000	0.011	0.544	0.134	0.314	0.000
	6	0.000	0.000	0.000	0.001	0.011	1.000	0.000	0.187	0.000	0.000
	7	0.000	0.001	0.239	0.969	0.544	0.000	1.000	0.022	0.850	0.000
	221	0.000	0.000	0.000	0.048	0.134	0.187	0.022	1.000	0.024	0.000
	225	0.000	0.117	0.589	0.710	0.314	0.000	0.850	0.024	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
g-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.377	0.043	0.000	0.000	0.000	0.001	0.008	0.000
	3	0.000	0.377	1.000	0.137	0.018	0.000	0.004	0.010	0.081	0.000
	4	0.000	0.043	0.137	1.000	0.336	0.009	0.247	0.162	0.517	0.000
	5	0.000	0.000	0.018	0.336	1.000	0.142	0.936	0.984	0.590	0.000
	6	0.000	0.000	0.000	0.009	0.142	1.000	0.121	0.192	0.057	0.002
	7	0.000	0.000	0.004	0.247	0.936	0.121	1.000	0.871	0.539	0.000
	221	0.000	0.001	0.010	0.162	0.984	0.192	0.871	1.000	0.542	0.000
	225	0.000	0.008	0.081	0.517	0.590	0.057	0.539	0.542	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	1.000

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a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

Table J-6c
SUMMARY OF NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS BASED ON ION RATIO MODIFIED CONCENTRATIONS^{a,b,c,d}

Sampling/ Comparison Area		Totals Over All LCLCs									
		EDA Sampliing Areas							Comparison Area		
		1	2	3	4	5	6	7	221	225	C&T
1	++		0	0	0	0	0	0	0	0	0
	+		0	0	0	0	0	6	0	0	0
	o		1	1	1	1	1	1	1	1	1
	-		0	0	0	0	0	0	0	0	0
	--		7	7	7	7	7	7	7	7	7
2	++	7		0	0	0	0	0	0	0	0
	+	0		0	0	0	0	0	1	0	0
	o	1		6	1	2	2	2	1	3	1
	-	0		1	2	0	0	0	0	0	0
	--	0		1	5	6	6	6	6	5	7
3	++	7	1		0	0	0	1	0	1	0
	+	0	1		0	0	0	0	1	0	0
	o	1	6		5	4	1	3	1	2	1
	-	0	0		0	3	1	0	1	1	0
	--	0	0		3	1	6	4	5	4	7
4	++	7	5	3		0	0	0	1	0	0
	+	0	2	0		1	1	1	1	2	0
	o	1	1	5		7	3	7	4	6	2
	-	0	0	0		0	2	0	2	0	0
	--	0	0	0		0	2	0	0	0	6
5	++	7	6	1	0		0	0	0	0	0
	+	0	0	3	0		0	0	0	1	0
	o	1	2	4	7		4	8	7	7	2
	-	0	0	0	1		2	0	1	0	0
	--	0	0	0	0		2	0	0	0	6
6	++	7	6	6	2	2		4	4	3	0
	+	0	0	1	2	2		1	0	1	0
	o	1	2	1	4	4		3	4	4	2
	-	0	0	0	0	0		0	0	0	0
	--	0	0	0	0	0		0	0	0	6

Table J-6c
(continued)

Sampling/ Comparison Area		Totals over all LCLCs									
		EDA Sampliing Areas							Comparison Area		
		1	2	3	4	5	6	7	221	225	C&T
7	++	7	6	4	0	0	0		0	0	0
	+	0	0	0	0	0	0		0	0	0
	o	1	2	3	6	8	3		7	8	0
	-	0	0	0	1	0	1		1	0	1
	--	0	0	1	1	0	4		0	0	7
221	++	7	6	4	0	0	0	0		0	0
	+	0	0	2	2	1	0	1		1	0
	o	1	1	1	4	7	4	7		7	0
	-	0	1	1	1	0	0	0		0	2
	--	0	0	0	1	0	4	0		0	6
225	++	7	5	1	0	0	0	0	0		0
	+	0	0	1	0	0	0	0	0		0
	o	1	3	5	6	7	4	8	7		1
	-	0	0	0	2	1	1	0	1		1
	--	0	0	1	0	0	3	0	0		6
C&T	++	7	7	7	6	6	6	7	6	6	
	+	0	0	0	0	0	0	1	2	1	
	o	1	1	1	2	2	2	0	0	1	
	-	0	0	0	0	0	0	0	0	0	
	--	0	0	0	0	0	0	0	0	0	

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a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

Table J-7a
RESULTS FOR NONPARAMETRIC MULTIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS BASED ON ION RATIO-MODIFIED CONCENTRATIONS[a,b,c,d]

Sampling/ Comparison Area	EDA Sampling Area							Comparison Areas		
	1	2	3	4	5	6	7	221	225	C&T
1		--	--	--	--	--	--	--	--	--
2	++		o	--	--	--	--	--	--	--
3	++	o		--	--	--	--	--	-	--
4	++	++	++		o	o	++	++	o	--
5	++	++	++	o		o	+	o	o	--
6	++	++	++	o	o		+	++	+	--
7	++	++	++	--	-	-		-	o	--
221	++	++	++	--	o	--	+		o	--
225	++	++	+	o	o	-	o	o		--
C&T	++	++	++	++	++	++	++	++	++	

---

a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling comparison area at 0.01 significance level.

b. The direction of the difference between the EDA and Comparison Areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

Table J-7b
TWO-SIDED p-VALUES FOR NONPARAMETRIC MULTIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS BASED ON ION RATIO-MODIFIED CONCENTRATIONS[a,b]

Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
	1	2	3	4	5	6	7	221	225	C&T
1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	1.000	0.591	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.591	1.000	0.004	0.000	0.000	0.000	0.000	0.032	0.000
4	0.000	0.000	0.004	1.000	0.094	0.056	0.006	0.003	0.070	0.000
5	0.000	0.000	0.000	0.094	1.000	0.283	0.040	0.115	0.062	0.000
6	0.000	0.000	0.000	0.056	0.283	1.000	0.010	0.003	0.023	0.000
7	0.000	0.000	0.000	0.006	0.040	0.010	1.000	0.015	0.924	0.000
221	0.000	0.000	0.000	0.003	0.115	0.003	0.015	1.000	0.083	0.000
225	0.000	0.000	0.032	0.070	0.062	0.023	0.924	0.083	1.000	0.000
C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

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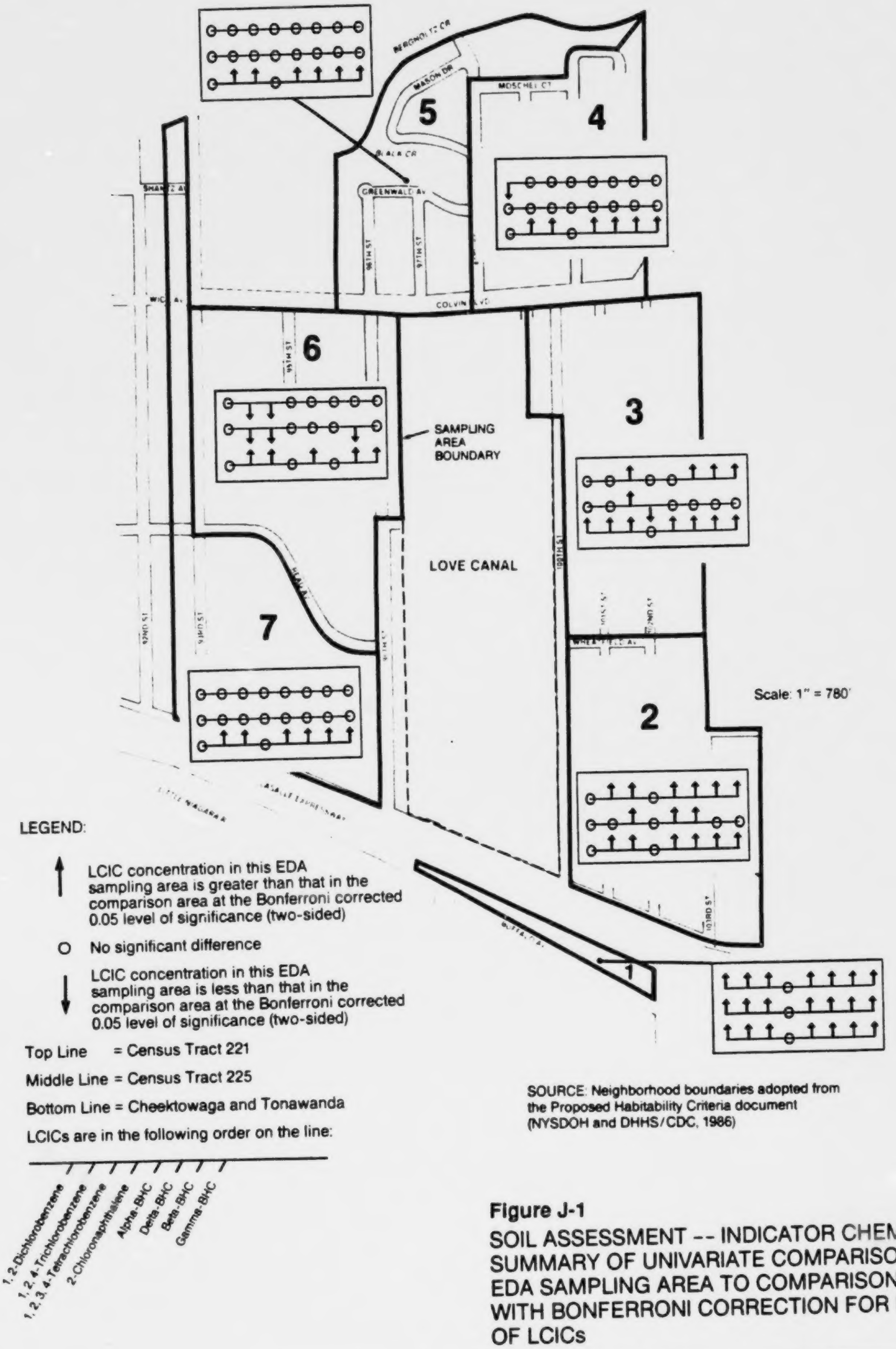
a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.


5
○ ○ ○ ○ ○ ○ ○ ○
○ ○ ○ ○ ○ ○ ○ ○
○ ↑ ↑ ○ ↑ ↑ ↑ ↑
4
↓ ○ ○ ○ ○ ○ ○ ○
○ ○ ○ ○ ○ ○ ○ ○
○ ↑ ↑ ○ ↑ ↑ ↑ ↑
6
○ ↓ ↓ ○ ○ ○ ○ ○
○ ↓ ↓ ○ ○ ○ ↓ ○
○ ↑ ↑ ○ ↑ ○ ↑ ↑
3
○ ○ ↑ ○ ○ ↑ ↑ ↑
○ ○ ↑ ↓ ○ ○ ○ ○
↑ ↑ ↑ ○ ↑ ↑ ↑ ↑
7
○ ○ ○ ○ ○ ○ ○ ○
○ ○ ○ ○ ○ ○ ○ ○
○ ↑ ↑ ○ ↑ ↑ ↑ ↑
2
○ ↑ ↑ ○ ↑ ↑ ↑ ↑
○ ○ ↑ ○ ↑ ↑ ○ ○
○ ↑ ↑ ○ ↑ ↑ ↑ ↑
1
↑ ↑ ↑ ○ ↑ ↑ ↑ ↑
↑ ↑ ↑ ○ ↑ ↑ ↑ ↑
↑ ↑ ↑ ○ ↑ ↑ ↑ ↑
BERGHOLTZ CR
MASON DR
MOSCHEL CT
BLACK CR
GREENWALD AV
SHANTZ AV
96TH ST
97TH ST
WICK AV
COLVIN BLVD
95TH ST
SAMPLING AREA BOUNDARY
LOVE CANAL
100TH ST
101ST ST
102ND ST
WHEATFIELD AV
93RD ST
92ND ST
99TH ST
LITTLE NIAGARA R
LASALLE EXPRESSWAY
BUFFALO AV
103RD ST
Scale: 1" = 780'

LEGEND:

↑ LCIC concentration in this EDA sampling area is greater than that in the comparison area at the Bonferroni corrected 0.05 level of significance (two-sided)

○ No significant difference

↓ LCIC concentration in this EDA sampling area is less than that in the comparison area at the Bonferroni corrected 0.05 level of significance (two-sided)

Top Line = Census Tract 221

Middle Line = Census Tract 225

Bottom Line = Cheektowaga and Tonawanda

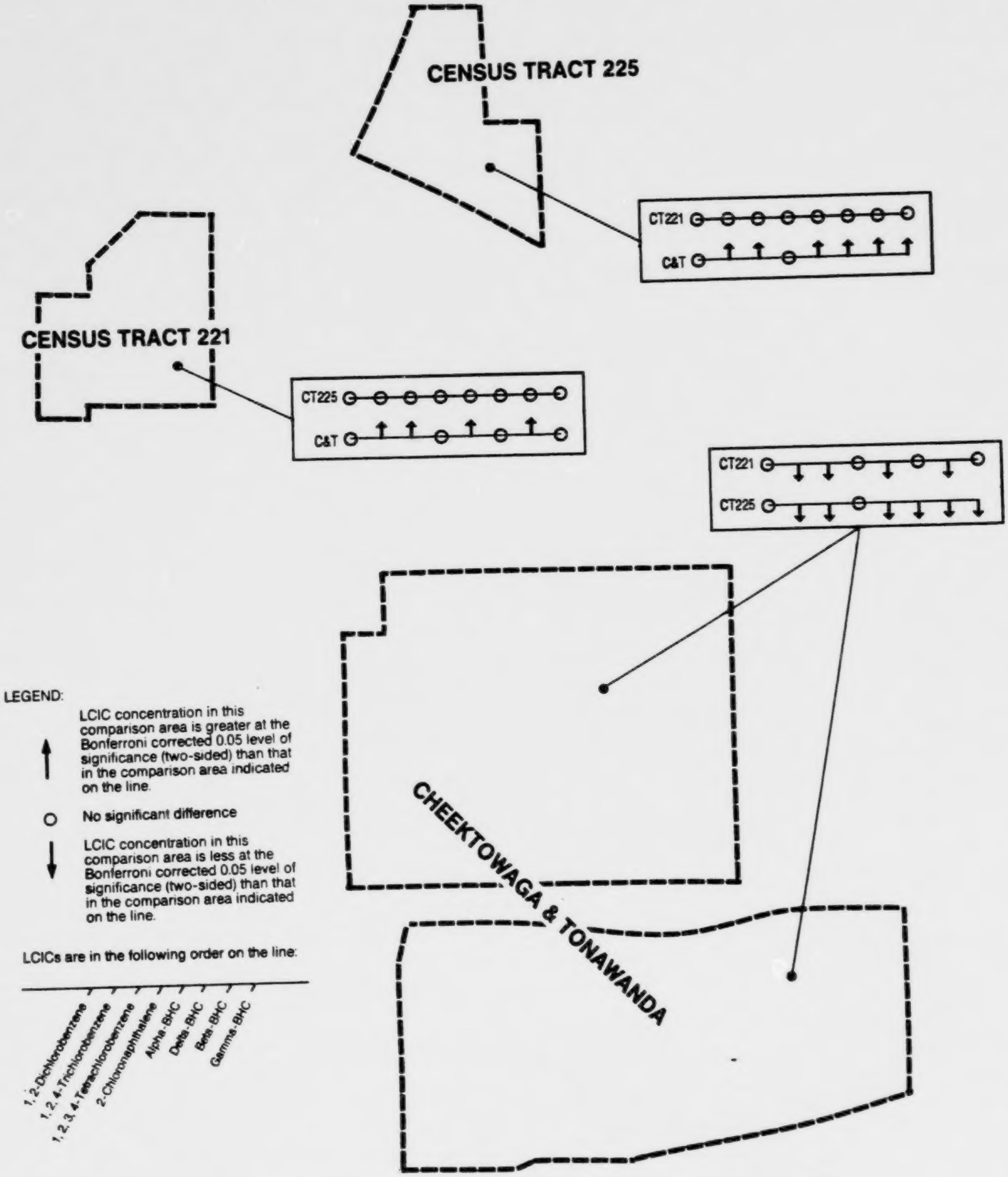
LCICs are in the following order on the line:

1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
1,2,3,4-Tetrachlorobenzene
2-Chloronaphthalene
Alpha-BHC
Delta-BHC
Beta-BHC
Gamma-BHC

SOURCE: Neighborhood boundaries adopted from the Proposed Habitability Criteria document (NYSDOH and DHHS/CDC, 1986)

Figure J-1

SOIL ASSESSMENT -- INDICATOR CHEMICALS SUMMARY OF UNIVARIATE COMPARISONS: EDA SAMPLING AREA TO COMPARISON AREA WITH BONFERRONI CORRECTION FOR NUMBER OF LCICs


CENSUS TRACT 225
CT221 ○ ○ ○ ○ ○ ○ ○ ○
C&T ○ ↑ ↑ ○ ↑ ↑ ↑ ↑
CENSUS TRACT 221
CT225 ○ ○ ○ ○ ○ ○ ○ ○
C&T ○ ↑ ↑ ○ ↑ ○ ↑ ○
CT221 ○ ↓ ↓ ○ ↓ ○ ↓ ○
CT225 ○ ↓ ↓ ○ ↓ ↓ ↓ ↓
CHEEKTOWAGA & TONAWANDA

LEGEND:

↑ LCIC concentration in this comparison area is greater at the Bonferroni corrected 0.05 level of significance (two-sided) than that in the comparison area indicated on the line.

○ No significant difference

↓ LCIC concentration in this comparison area is less at the Bonferroni corrected 0.05 level of significance (two-sided) than that in the comparison area indicated on the line.

LCICs are in the following order on the line:

1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
1,2,3,4-Tetrachlorobenzene
2-Chloronaphthalene
Alpha-BHC
Delta-BHC
Beta-BHC
Gamma-BHC

Figure J-2

SOIL ASSESSMENT -- INDICATOR CHEMICALS SUMMARY OF UNIVARIATE COMPARISONS: COMPARISON AREA TO COMPARISON AREA WITH BONFERRONI CORRECTION FOR NUMBER OF LCICs

APPENDIX K
Summary of Sensitivity Results by EDA Sampling Area

Soil Assessment--Indicator Chemicals

Appendix K

SUMMARY OF SENSITIVITY RESULTS BY EDA SAMPLING AREA SOIL ASSESSMENT--INDICATOR CHEMICALS

In response to a comment from Dr. David Schoenfeld at the peer review meeting, this appendix presents the results of the statistical comparisons between the EDA sampling areas and the comparisons areas by sampling area. The results are presented in Tables K-1 through 7 (one table for each EDA sampling area). Most of these results were presented in Volume III; however, the results in Volume III were grouped by LCIC rather than by sampling area.

It should be emphasized that the peer review panel has recommended that the results of the original comparisons (presented in Tables 6-8 through 6-10, K-1 and K-2, and Figures 6-9 through 6-11 of Volume III) should be the primary basis for the habitability decision.

The results of the sensitivity analyses conducted on the comparisons are also presented in these tables. The issues addressed by each sensitivity analysis are explained below.

Tables K-4 through K-8 of Volume III present the results of a sensitivity analysis that explores the effect of relaxing the data quality control to include Uncertain data, as well as the Good data. A description of the meaning of the data qualifiers "Good" and "Uncertain" is provided in Appendix H (page H-23) of Volume III.

The sensitivity analysis that includes data with the usability flag of Uncertain explores the effect of expanding the data base to include data that has some QA/QC problems. The extent to which the comparison results change when the expanded data set is used yields information on how sensitive the comparison analysis is to the particular set of data used.

Tables K-9 through K-11 of Volume III present the results of a sensitivity analysis that explores the effect of classifying all data below 1.0 ppb as non-detects. The purpose of this sensitivity analysis, as stated in Volume III, is to assess the sensitivity of the comparisons to the laboratory detection limits. "If the results had changed dramatically with the (artificially) increased detection limits, then it could be concluded that the detection limits were exerting a strong influence on the results" (Volume III, page 5-10).

This sensitivity analysis also addresses another issue, determining the effects of outliers on the statistical comparisons. Such a sensitivity analysis was requested by a peer reviewer in the written preliminary comments (Dr. David

Schoenfeld, page 3). Because most observations are less than 1.0 ppb for most LCICs (except for TCB and TeCB; see below) in the EDA sampling areas and comparison areas (except for EDA Sampling Area 1), the effect of treating all observations less than or equal to 1.0 ppb as non-detect is to emphasize the characteristic of the Wilcoxon rank sum test that evaluates for differences in the upper tails of the distributions. That is, this modification can be used to test whether there are more outlying high values in one EDA sampling area or comparison area than in another.

For the LCICs TCB and TeCB, most observations are less than 2.0 ppb; thus, a peer reviewer (Dr. David Schoenfeld--Peer Review Meeting Comment, June 21, 1988) requested that a similar analysis be performed for these LCICs with the cutoff at 2.0 ppb rather than 1.0 ppb.

At the request of the TRC, a sensitivity analysis was performed that explores the effects of deleting the largest 10 percent of the observations for each LCIC in each EDA sampling area and comparison area. The question this sensitivity analysis proposes to answer is whether a few large values in any particular EDA sampling area or comparison area have a large influence on the outcome of the statistical comparisons.

It was not possible to perform a meaningful multivariate analysis based on an upper 10 percent trim of the multivariate observations, because an upper 10 percent trim is not well-defined for a multivariate observation: for any particular EDA sampling area or comparison area, the samples with the largest 10 percent of the observations for one LCIC may not correspond to the largest 10 percent of the observations for another LCIC.

At the request of the TRC, a sensitivity analysis was performed that explores the effects of reclassifying non-detects as detects if the only reason for the non-detect classification was that the observed primary-to-secondary ion ratio deviated from the theoretical ratio by more than 20 percent but not more than 40 percent. The purpose of this sensitivity analysis is to explore the effects of LCIC interferences on the statistical comparisons.

WDR363/001

Table K-1

SUMMARY OF SENSITIVITY RESULTS FOR EDA SAMPLING AREA 1[a,b,c,d,e]

LCIC	Comparison Area	Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
		Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
DCB			1.01		1.01		1.01		ND		0.94		1.01
	221	0.39	++	0.40	++	ND	++	ND	++	0.38	++	0.39	++
	225	0.43	++	0.42	++	ND	++	ND	++	0.39	++	0.43	++
	C&T	0.36	++	0.36	++	ND	++	ND	++	0.35	++	0.36	++
TCB			8.67		8.67		8.67		8.67		7.80		8.67
	221	0.65	++	0.64	++	ND	++	ND	++	0.63	++	0.65	++
	225	0.60	++	0.60	++	ND	++	ND	++	0.56	++	0.60	++
	C&T	0.13	++	0.14	++	ND	++	ND	++	0.13	++	0.13	++
TeCB			11.48		12.93		11.48		11.48		11.34		11.48
	221	0.53	++	0.55	++	ND	++	ND	++	0.50	++	0.53	++
	225	0.61	++	0.64	++	ND	++	ND	++	0.54	++	0.61	++
	C&T	0.05	++	0.05	++	ND	++	ND	++	0.05	++	0.05	++
CNP			ND		ND		ND		ND		ND		0.06
	221	0.06	o	0.06	o	ND	o	ND	o	0.05	-	0.07	o
	225	0.07	-	0.07	-	ND	o	ND	o	0.07	-	0.07	o
	C&T	0.03	o	0.03	o	ND	o	ND	o	0.02	o	0.04	o
a-BHC			8.25		9.47		8.25		8.25		7.51		8.25
	221	0.18	++	0.18	++	ND	++	ND	++	0.18	++	0.18	++
	225	0.11	++	0.11	++	ND	++	ND	++	0.07	++	0.15	++
	C&T	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
d-BHC			1.13		1.20		1.13		ND		0.79		1.39
	221	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
	225	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
	C&T	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
b-BHC			11.58		11.68		11.58		11.58		10.73		11.58
	221	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
	225	ND	++	ND	++	ND	++	ND	++	ND	++	0.12	++
	C&T	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++

Table K-1
(Continued)

LCIC	Comparison Area	Original Median Conc. (ppb)	Original Test Result	Good And Uncertain Median Conc. (ppb)	Good And Uncertain Test Result	≤1 ppb Non-detect Median Conc. (ppb)	≤1 ppb Non-detect Test Result	≤2 ppb Non-detect Median Conc. (ppb)	≤2 ppb Non-detect Test Result	Upper 10% Trim Median Conc. (ppb)	Upper 10% Trim Test Result	Ion Ratio Modified Median Conc. (ppb)	Ion Ratio Modified Test Result
g-BHC		1.73		1.73		1.73		ND		1.48		1.48	
	221	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
	225	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
	C&T	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
ALL	221		++		++	Could		Could		Could			++
	225		++		++	Not be		Not be		Not be			++
	C&T		++		++	Determined		Determined		Determined			++

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[a] ++ = EDA sampling area > comparison area at 0.01 significance level.
+ = EDA sampling area > comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = EDA sampling area < comparison area at 0.05 significance level.
-- = EDA sampling area < comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The first entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

[e] For multivariate results (All), the direction of the difference between the EDA and the comparison areas is based on the sine of the sum of the elements of the 8x1 vector of rank sums (Vol. III, Appendix B).

Table K-2

SUMMARY OF SENSITIVITY RESULTS FOR EDA SAMPLING AREA 2[a,b,c,d,e]

		Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
LCIC	Comparison Area	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
DCB			0.39		0.41		ND		ND		0.35		0.39
	221	0.39	o	0.40	o	ND	o	ND	o	0.38	o	0.39	o
	225	0.43	o	0.42	o	ND	o	ND	o	0.39	o	0.43	o
	C&T	0.36	++	0.36	+	ND	o	ND	o	0.35	++	0.36	++
TCB			0.91		0.88		ND		ND		0.83		0.91
	221	0.65	++	0.64	++	ND	++	ND	+	0.63	++	0.65	++
	225	0.60	++	0.60	+	ND	o	ND	o	0.56	++	0.60	++
	C&T	0.13	++	0.14	++	ND	++	ND	++	0.13	++	0.13	++
TeCB			1.17		1.12		1.17		ND		1.09		1.17
	221	0.53	++	0.55	++	ND	++	ND	++	0.50	++	0.53	++
	225	0.61	++	0.64	++	ND	++	ND	o	0.54	++	0.61	++
	C&T	0.05	++	0.05	++	ND	++	ND	++	0.05	++	0.05	++
CNP			0.04		0.04		ND		ND		0.04		0.05
	221	0.06	o	0.06	o	ND	o	ND	o	0.05	-	0.07	-
	225	0.07	-	0.07	-	ND	o	ND	o	0.07	--	0.07	o
	C&T	0.03	o	0.03	o	ND	o	ND	o	0.02	o	0.04	o
a-BHC			0.40		0.36		ND		ND		0.35		0.40
	221	0.18	++	0.18	++	ND	++	ND	+	0.18	++	0.18	++
	225	0.11	++	0.11	++	ND	o	ND	o	0.07	++	0.15	++
	C&T	ND	++	ND	++	ND	++	ND	+	ND	++	ND	++
d-BHC			0.04		ND		ND		ND		ND		0.10
	221	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
	225	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
b-BHC			0.20		0.19		ND		ND		0.17		0.29
	221	ND	++	ND	++	ND	++	ND	+	ND	++	ND	++
	225	ND	o	ND	o	ND	o	ND	o	ND	o	0.12	o
	C&T	ND	++	ND	++	ND	++	ND	o	ND	++	ND	++

Table K-2
(Continued)

LCIC	Comparison Area	Original Median Conc. (ppb)	Original Test Result	Good And Uncertain Median Conc. (ppb)	Good And Uncertain Test Result	≤1 ppb Non-detect Median Conc. (ppb)	≤1 ppb Non-detect Test Result	≤2 ppb Non-detect Median Conc. (ppb)	≤2 ppb Non-detect Test Result	Upper 10% Trim Median Conc. (ppb)	Upper 10% Trim Test Result	Ion Ratio Modified Median Conc. (ppb)	Ion Ratio Modified Test Result
g-BHC			0.09		0.05		ND		ND		0.03		0.09
	221	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
	225	ND	+	ND	+	ND	o	ND	o	ND	++	ND	++
	C&T	ND	++	ND	++	ND	++	ND	o	ND	++	ND	++
ALL	221		++		++	No Results Here		No Results Here		No Results Here			++
	225		++		++								++
	C&T		++		++								++

---

[a] ++ = EDA sampling area > comparison area at 0.01 significance level.
+ = EDA sampling area > comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = EDA sampling area < comparison area at 0.05 significance level.
-- = EDA sampling area < comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The first entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda. 221 = Census Tract 221. 225 = Census Tract 225.

[e] For multivariate results (ALL), the direction of the difference between the EDA sampling area and the comparison area is based on the sine of the sum of the elements of the 8x1 vector of rank sums (Vol. III, Appendix B).

Table K-3
SUMMARY OF SENSITIVITY RESULTS FOR EDA SAMPLING AREA 3[a,b,c,d,e]

		Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
LCIC	Comparison Area	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
DCB			0.40		0.42		ND		ND		0.39		0.40
	221	0.39	o	0.40	o	ND	o	ND	o	0.38	o	0.39	o
	225	0.43	o	0.42	o	ND	o	ND	o	0.39	o	0.43	o
	C&T	0.36	++	0.36	++	ND	o	ND	o	0.35	++	0.36	++
TCB			0.89		0.89		ND		ND		0.79		0.89
	221	0.65	+	0.64	++	ND	++	ND	o	0.63	+	0.65	+
	225	0.60	+	0.60	+	ND	o	ND	o	0.56	++	0.60	+
	C&T	0.13	++	0.14	++	ND	++	ND	++	0.13	++	0.13	++
TeCB			1.06		1.07		1.06		ND		0.94		1.06
	221	0.53	++	0.55	++	ND	++	ND	++	0.50	++	0.53	++
	225	0.61	++	0.64	++	ND	+	ND	o	0.54	++	0.61	++
	C&T	0.05	++	0.05	++	ND	++	ND	++	0.05	++	0.05	++
CNP			0.04		ND		ND		ND		ND		0.05
	221	0.06	o	0.06	o	ND	o	ND	o	0.05	-	0.07	-
	225	0.07	-	0.07	-	ND	o	ND	o	0.07	--	0.07	--
	C&T	0.03	o	0.03	o	ND	o	ND	o	0.02	o	0.04	o
a-BHC			0.22		0.22		ND		ND		0.18		0.24
	221	0.18	o	0.18	+	ND	++	ND	o	0.18	o	0.18	+
	225	0.11	o	0.11	o	ND	o	ND	o	0.07	o	0.15	o
	C&T	ND	++	ND	++	ND	++	ND	+	ND	++	ND	++
d-BHC			ND		ND		ND		ND		ND		ND
	221	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
	225	ND	o	ND	o	ND	o	ND	o	ND	+	ND	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
b-BHC			0.13		0.07		ND		ND		ND		0.15
	221	ND	++	ND	++	ND	+	ND	+	ND	++	ND	++
	225	ND	o	ND	o	ND	o	ND	o	ND	o	0.12	o
	C&T	ND	++	ND	++	ND	++	ND	+	ND	++	ND	++

Table K-3
(Continued)

		Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
LCIC	Comparison Area	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
g-BHC			ND		ND		ND		ND		ND		ND
	221	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
	225	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	C&T	ND	++	ND	++	ND	+	ND	o	ND	++	ND	++
ALL	221		++		++	No Results Here		No Results Here		No Results Here			++
	225		+		o								+
	C&T		++		++								++

---

[a] ++ = EDA sampling area > comparison area at 0.01 significance level.
+ = EDA sampling area > comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = EDA sampling area < comparison area at 0.05 significance level.
-- = EDA sampling area < comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The first entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

[e] For multivariate results (ALL), the direction of the difference between the EDA sampling area and the comparison area is based on the sine of the sum of the elements of the 8x1 vector of rank sums (Vol. III, Appendix B).

Table K-4
SUMMARY OF SENSITIVITY RESULTS FOR EDA SAMPLING AREA 4^{a,b,c,d,e}

		Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
LCIC	Comparison Area	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
DCB			0.36		0.38		ND		ND		0.33		0.36
	221	0.39	--	0.40	--	ND	o	ND	o	0.38	--	0.39	--
	225	0.43	-	0.42	o	ND	o	ND	o	0.39	-	0.43	-
	C&T	0.36	o	0.36	o	ND	o	ND	o	0.35	o	0.36	o
TCB			0.43		0.45		ND		ND		0.41		0.44
	221	0.65	-	0.64	-	ND	o	ND	o	0.63	--	0.65	-
	225	0.60	o	0.60	o	ND	o	ND	o	0.56	o	0.60	o
	C&T	0.13	++	0.14	++	ND	++	ND	+	0.13	++	0.13	++
TeCB			0.38		0.42		ND		ND		0.35		0.39
	221	0.53	-	0.55	o	ND	+	ND	+	0.50	--	0.53	o
	225	0.61	o	0.64	o	ND	o	ND	o	0.54	-	0.61	o
	C&T	0.05	++	0.05	++	ND	++	ND	++	0.05	++	0.05	++
CNP			0.04		0.04		ND		ND		0.04		0.04
	221	0.06	o	0.06	o	ND	o	ND	o	0.05	o	0.07	o
	225	0.07	-	0.07	-	ND	o	ND	o	0.07	o	0.07	-
	C&T	0.03	o	0.03	o	ND	o	ND	o	0.02	o	0.04	o
a-BHC			0.12		0.12		ND		ND		0.08		0.13
	221	0.18	o	0.18	o	ND	++	ND	+	0.18	o	0.18	o
	225	0.11	o	0.11	o	ND	o	ND	o	0.07	o	0.15	o
	C&T	ND	++	ND	++	ND	++	ND	++	ND	++	ND	++
d-BHC			ND		ND		ND		ND		ND		ND
	221	ND	+	ND	++	ND	o	ND	o	ND	+	ND	+
	225	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
b-BHC			ND		ND		ND		ND		ND		0.07
	221	ND	+	ND	+	ND	++	ND	++	ND	+	ND	+
	225	ND	o	ND	o	ND	o	ND	o	ND	o	0.12	o
	C&T	ND	++	ND	++	ND	++	ND	+	ND	++	ND	++

Table K-4
(Continued)

LCIC	Comparison Area	Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
		Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
g-BHC			ND		ND		ND		ND		ND		ND
	221	ND	+	ND	+	ND	o	ND	o	ND	+	ND	o
	225	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
ALL	221		--		--	No		No		No			--
	225		o		o	Results		Results		Results			o
	C&T		++		++	Here		Here		Here			++

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[a] ++ = EDA sampling area > comparison area at 0.01 significance level.
+ = EDA sampling area > comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = EDA sampling area < comparison area at 0.05 significance level.
-- = EDA sampling area < comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The first entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

[e] For multivariate results (ALL), the direction of the difference between the EDA sampling area and the comparison area is based on the sine of the sum of the elements of the 8x1 vector of rank sums (Vol. III, Appendix B).

Table K-5
SUMMARY OF SENSITIVITY RESULTS FOR EDA SAMPLING AREA 5[a,b,c,d,e]

LCIC	Comparison Area	Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
		Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
DCB			0.39		0.39		ND		ND		0.36		0.39
	221	0.39	o	0.40	o	ND	o	ND	o	0.38	o	0.39	o
	225	0.43	o	0.42	o	ND	o	ND	o	0.39	o	0.43	o
	C&T	0.36	o	0.36	o	ND	o	ND	o	0.35	o	0.36	o
TCB			0.52		0.57		ND		ND		0.44		0.50
	221	0.65	o	0.64	o	ND	o	ND	+	0.63	o	0.65	o
	225	0.60	o	0.60	o	ND	o	ND	o	0.56	o	0.60	o
	C&T	0.13	++	0.14	++	ND	++	ND	++	0.13	++	0.13	++
TeCB			0.43		0.46		ND		ND		0.38		0.43
	221	0.53	o	0.55	o	ND	++	ND	++	0.50	o	0.53	o
	225	0.61	o	0.64	o	ND	o	ND	o	0.54	o	0.61	o
	C&T	0.05	++	0.05	++	ND	++	ND	++	0.05	++	0.05	++
CNP			0.06		0.06		ND		ND		0.05		0.06
	221	0.06	o	0.06	o	ND	o	ND	o	0.05	o	0.07	o
	225	0.07	-	0.07	-	ND	o	ND	o	0.07	-	0.07	-
	C&T	0.03	o	0.03	o	ND	o	ND	o	0.02	o	0.04	o
a-BHC			0.13		0.14		ND		ND		0.06		0.14
	221	0.18	o	0.18	o	ND	+	ND	+	0.18	o	0.18	o
	225	0.11	o	0.11	o	ND	o	ND	o	0.07	o	0.15	o
	C&T	ND	++	ND	++	ND	++	ND	+	ND	++	ND	++
d-BHC			ND		ND		ND		ND		ND		ND
	221	ND	+	ND	+	ND	o	ND	o	ND	++	ND	+
	225	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
b-BHC			ND		ND		ND		ND		ND		ND
	221	ND	o	ND	o	ND	+	ND	+	ND	o	ND	o
	225	ND	o	ND	o	ND	o	ND	o	ND	-	0.12	o
	C&T	ND	++	ND	++	ND	+	ND	o	ND	++	ND	++

Table K-5
(Continued)

LCIC	Comparison Area	Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
		Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
g-BHC			ND		ND		ND		ND		ND		ND
	221	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	225	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	C&T	ND	++	ND	++	ND	+	ND	+	ND	++	ND	++
ALL	221		+		-	No Results Here		No Results Here		No Results Here			o
	225		-		-								o
	C&T		++		++								++

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[a] ++ = EDA sampling area > comparison area at 0.01 significance level.
+ = EDA sampling area > comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = EDA sampling area < comparison area at 0.05 significance level.
-- = EDA sampling area < comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The first entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

[e] For multivariate results (ALL), the direction of the difference between the EDA sampling area and the comparison area is based on the sine of the sum of the elements of the 8x1 vector of rank sums (Vol. III, Appendix B).

Table K-6

SUMMARY OF SENSITIVITY RESULTS FOR EDA SAMPLING AREA $6^{a,b,c,d,e}$

LCIC	Comparison Area	Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
		Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
DCB			0.36		0.36		ND		ND		0.33		0.36
	221	0.39	--	0.40	-	ND	o	ND	o	0.38	--	0.39	--
	225	0.43	o	0.42	o	ND	o	ND	o	0.39	o	0.43	o
	C&T	0.36	o	0.36	o	ND	o	ND	o	0.35	o	0.36	o
TCB			0.37		0.38		ND		ND		0.36		0.37
	221	0.65	--	0.64	--	ND	--	ND	o	0.63	--	0.65	--
	225	0.60	--	0.60	--	ND	--	ND	--	0.56	--	0.60	--
	C&T	0.13	++	0.14	++	ND	o	ND	o	0.13	++	0.13	++
TeCB			0.31		0.32		ND		ND		0.28		0.31
	221	0.53	--	0.55	--	ND	o	ND	o	0.50	--	0.53	--
	225	0.61	--	0.64	--	ND	--	ND	--	0.54	--	0.61	--
	C&T	0.05	++	0.05	++	ND	o	ND	o	0.05	++	0.05	++
CNP			0.05		0.05		ND		ND		0.05		0.07
	221	0.06	o	0.06	o	ND	o	ND	o	0.05	o	0.07	o
	225	0.07	-	0.07	-	ND	o	ND	o	0.07	o	0.07	o
	C&T	0.03	o	0.03	o	ND	o	ND	o	0.02	o	0.04	o
a-BHC			0.07		0.07		ND		ND		0.06		0.10
	221	0.18	-	0.18	-	ND	o	ND	o	0.18	--	0.18	--
	225	0.11	o	0.11	o	ND	-	ND	--	0.07	o	0.15	-
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
d-BHC			ND		ND		ND		ND		ND		ND
	221	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	225	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	C&T	ND	++	ND	+	ND	o	ND	o	ND	o	ND	++
b-BHC			ND		ND		ND		ND		ND		ND
	221	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	225	ND	--	ND	--	ND	o	ND	o	ND	--	0.12	--
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++

Table K-6
(Continued)

LCIC	Comparison Area	Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
		Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
g-BHC			ND		ND		ND		ND		ND		ND
	221	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	225	ND	-	ND	--	ND	-	ND	o	ND	--	ND	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	+	ND	++
ALL	221		--		--	No Results Here		No Results Here		No Results Here			--
	225		-		--								-
	C&T		++		++								++

---

[a] ++ = EDA sampling area > comparison area at 0.01 significance level.
 + = EDA sampling area > comparison area at 0.05 significance level.
 o = No significant difference at 0.05 significance level.
 - = EDA sampling area < comparison area at 0.05 significance level.
 -- = EDA sampling area < comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The first entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

[e] For multivariate results (ALL), the direction of the difference between the EDA sampling area and the comparison area is based on the sine of the sum of the elements of the 8x1 vector of rank sums (Vol. III, Appendix B).

Table K-7
SUMMARY OF SENSITIVITY RESULTS FOR EDA SAMPLING AREA $7^{a,b,c,d,e}$

		Original		Good And Uncertain		≤1 ppb Non-detect		≤2 ppb Non-detect		Upper 10% Trim		Ion Ratio Modified	
LCIC	Comparison Area	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result	Median Conc. (ppb)	Test Result
DCB			0.41		0.41		ND		ND		0.38		0.41
	221	0.39	o	0.40	o	ND	-	ND	o	0.38	o	0.39	o
	225	0.43	o	0.42	o	ND	o	ND	o	0.39	o	0.43	o
	C&T	0.36	+	0.36	+	ND	o	ND	o	0.35	++	0.36	+
TCB			0.58		0.59		ND		ND		0.54		0.58
	221	0.65	o	0.64	o	ND	o	ND	o	0.63	o	0.65	o
	225	0.60	o	0.60	o	ND	o	ND	-	0.56	o	0.60	o
	C&T	0.13	++	0.14	++	ND	++	ND	o	0.13	++	0.13	++
TeCB			0.54		0.55		ND		ND		0.49		0.54
	221	0.53	o	0.55	o	ND	++	ND	o	0.50	o	0.53	o
	225	0.61	o	0.64	o	ND	o	ND	-	0.54	o	0.61	o
	C&T	0.05	++	0.05	++	ND	++	ND	o	0.05	++	0.05	++
CNP			0.06		0.05		ND		ND		0.05		0.06
	221	0.06	o	0.06	o	ND	o	ND	o	0.05	o	0.07	o
	225	0.07	-	0.07	-	ND	o	ND	o	0.07	o	0.07	o
	C&T	0.03	o	0.03	o	ND	o	ND	o	0.02	+	0.04	++
a-BHC			0.14		0.15		ND		ND		0.13		0.17
	221	0.18	o	0.18	o	ND	o	ND	o	0.18	o	0.18	o
	225	0.11	o	0.11	o	ND	--	ND	-	0.07	o	0.15	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
d-BHC			ND		ND		ND		ND		ND		ND
	221	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	225	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	o	ND	++
b-BHC			ND		ND		ND		ND		ND		0.10
	221	ND	o	ND	o	ND	o	ND	o	ND	+	ND	+
	225	ND	o	ND	o	ND	o	ND	o	ND	o	0.12	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++

Table K-7
(Continued)

LCIC	Comparison Area	Original Median Conc. (ppb)	Original Test Result	Good And Uncertain Median Conc. (ppb)	Good And Uncertain Test Result	≤1 ppb Non-detect Median Conc. (ppb)	≤1 ppb Non-detect Test Result	≤2 ppb Non-detect Median Conc. (ppb)	≤2 ppb Non-detect Test Result	Upper 10% Trim Median Conc. (ppb)	Upper 10% Trim Test Result	Ion Ratio Modified Median Conc. (ppb)	Ion Ratio Modified Test Result
g-BHC			ND		ND		ND		ND		ND		ND
	221	ND	o	ND	o	ND	o	ND	o	ND	o	ND	o
	225	ND	o	ND	o	ND	-	ND	o	ND	o	ND	o
	C&T	ND	++	ND	++	ND	o	ND	o	ND	++	ND	++
ALL	221		++		--	No Results Here		No Results Here		No Results Here			+
	225		o		o								o
	C&T		++		++								++

---

[a] ++ = EDA sampling area > comparison area at 0.01 significance level.
+ = EDA sampling area > comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = EDA sampling area < comparison area at 0.05 significance level.
-- = EDA sampling area < comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The first entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

[e] For multivariate results (ALL), the direction of the difference between the EDA sampling area and the comparison area is based on the sine of the sum of the elements of the 8x1 vector of rank sums (Vol. III, Appendix B).

APPENDIX L
Spatial and Correlation Structures of LCICs in the EDA

Soil Assessment--Indicator Chemicals

Appendix L

SPATIAL AND CORRELATION STRUCTURES OF LCICs IN THE EDA SOIL ASSESSMENT--INDICATOR CHEMICALS

Although the Love Canal soil assessment for indicator chemicals was not designed to analyze spatial and correlation structures (i.e., the assessment was concerned with comparing averages rather than with identifying hot spots), questions about such structures or patterns were raised during the peer review. While this appendix presents spatial and correlation structure analyses, the results of these analyses should be regarded as qualitative.

The correlation structure of the LCICs was examined to indicate the degree of association among the LCICs. Since both univariate and multivariate comparison analyses were conducted, knowledge of the correlations among the LCICs indicates how much weight should be given to multiple significant univariate differences.

The spatial structure of the LCICs was examined for indications that the comparison design assumptions were not violated. The sampling strategy of the comparison study was based on the assumption (on the basis of pilot study results) that there was no localized contamination by LCICs in the EDA (i.e., contamination, if present, would occur uniformly over the EDA). This meant that samples could be randomly allocated to each neighborhood and that the results of these random samples would be representative of the neighborhood.

One method of examining the spatial structure is to correlate LCICs with distance from the canal. Since one hypothesis for LCIC concentrations is that the LCICs migrated from the Canal, significant negative correlations would indicate that such a hypothesis might be valid.

A second method of examining the spatial structure is to generate semivariograms for each sampling area. This technique, adapted from Kriging, indicates whether sampled points correlated more with nearby points than those more distant. A consistent pattern in the semivariograms would indicate spatial structure at a resolution smaller than the sampling area.

Correlations among LCICs and analyses using the two methods of examining spatial structure are presented in separate sections below.

CORRELATIONS AMONG LCICs

Table L-1 presents Spearman rank (r) correlations among LCIC concentrations for all samples taken in both the EDA and the comparison areas. The concentrations of members of the same chemical family exhibit a relatively high degree of correlation. For example, the correlations among the BHC compounds (A, D, G, B) all exceed 0.5, with the correlation between A- and B-BHCs the strongest (r=0.71). The chlorobenzene compounds are also correlated, with the correlation strongest between TCB and TeCB (r=0.94), and weakest between DCB and TeCB (r=0.38). The most interesting aspect of the correlation matrix, however, is the observed relationship between members of different chemical families. For example, TCB and TeCB are highly correlated (r>0.75) with A-BHC. The correlations between these chlorobenzenes and the other BHC compounds are somewhat weaker, but not inconsequential (r>0.5). Plots demonstrating some of these relationships are given in Figures L-1 through 3. Note that, prior to plotting, the concentrations were transformed to the natural logarithm scale to reduce the influence of a single, large observation on the scale of the plot. In addition, 1 was added to each concentration prior to the logarithmic scaling. Thus, zero in the original scale transforms to zero in log scale.

The first question that might be asked is whether these correlations are related to the measurement process itself. In particular, one might ask whether the correlations are related to laboratory differences. This seems highly unlikely considering the magnitude of the correlations. However, to examine this possibility, laboratory-specific correlation matrices are presented in Tables L-2 through 8. From these matrices, we see that the correlation pattern is remarkably stable among laboratories. The relationship among the chlorobenzenes is similar, with the extraordinarily high (>0.9) correlation between TCB and TeCB common to all the laboratories. In addition, the pattern among the BHCs is similar in all the laboratories, and the relationship between the chlorobenzenes and BHCs is seen in each laboratory.

In the correlation matrices examined thus far, all samples were included irrespective of whether they came from the EDA or from the comparison areas. Because significant differences were found between the EDA sampling areas and the comparison areas, correlation matrices for the EDA and each of the comparison areas are given in Tables L-9 through 12.

From these matrices, it is shown that the combined comparison area of Cheektowaga and Tonawanda exhibits strong correlations among the chlorobenzenes, although it appears that the correlations are weaker than those seen in the EDA.

Because of the absence of the BHCs at any appreciable level in the Cheektowaga and Tonawanda samples, the correlations among these compounds are very low. For the same reason, the correlations between the BHCs and the chlorobenzenes are also smaller than those seen in the EDA.

Like the combined sampling area of Cheektowaga and Tonawanda, Census Tract 221 exhibits a correlation pattern among the chlorobenzenes that is quite similar to that found in the EDA. It also shows correlations between chlorobenzenes and the BHC compounds similar to those seen in EDA samples. Although the correlations are not as large as those from the EDA, there is evidence that a systematic relationship exists between the two families of chemicals in samples from Census Tract 221. Census Tract 225's correlation matrix is remarkably similar to that of the EDA. Although some of the correlations between the BHCs and the chlorobenzenes are not as strong as those seen in the EDA, the overall pattern is the same, namely, strong correlations between chlorobenzenes and BHC compounds.

In addition to the correlation analyses for laboratories and sampling areas, correlation matrices were obtained for combinations of laboratories and sampling areas. These analyses showed no apparent differences among the laboratories in any of the three comparison areas or the EDA. The correlation analyses provide evidence that there are fairly strong correlations among the chlorobenzenes used as LCICs. The relationship among these compounds exists and is of similar strength in samples taken from both the EDA and all the comparison areas. There is also evidence of somewhat weaker correlations among the BHC compounds in both the EDA and two of the comparison areas. Furthermore, one of the comparison areas exhibited correlations among the compounds that were nearly identical to those observed in EDA samples. Since the comparison areas exhibit similar relationships among the LCICs, this reduces the validity of using consistency of results across the LCICs as evidence of migration. The results of statistical analyses of individual LCICs should be interpreted with caution. If, for example, a comparison of TCB levels in an EDA sampling area and in Census Tract 225 yields a statistically significant result, we should not expect a similar result for TeCB to add much to the weight of evidence concerning contamination of the area. Thus, the multivariate test results, which take the correlation structure in the LCICs into account, are the most appropriate tools for assessing differences between the EDA and the comparison areas.

CORRELATION OF LCICs WITH DISTANCE FROM THE CANAL

To ascertain whether the levels of LCICs can be related to proximity to the Canal, an analysis using simple correlation techniques was conducted. To implement this analysis, individual data were mapped to obtain a general sense of the spatial orientation of the data. The concentrations for local groups of values of each LCIC were averaged on a grid encompassing the EDA and Census Tract 225. The comparison area was included to assess evidence of large-scale spatial trends across the EDA and the closest comparison area. Maps of the EDA and the closest comparison area (Census Tract 225) are shown in Figures L-4 through 11. In general, each plotted value represents an average of four or five sampling locations.

While there is little visual evidence that the LCIC concentrations decrease with distance from the Canal, a simple analysis to verify this initial conclusion was performed to assess the strength of spatial gradients in LCIC concentrations. Correlations of LCIC concentrations at the sampling locations with their distances from the center of the Canal and to the nearest boundary of the Canal were computed. The results are given below.

CORRELATION OF LCIC CONCENTRATION WITH DISTANCE FROM CENTER OF THE LOVE CANAL

Chemical	Spearman Correlation (r)	p-value H_0: r=0
DCB	0.100	0.028
TCB	0.092	0.042
TeCB	0.058	0.202
CNP	-0.002	0.954
A-BHC	0.138	0.002
D-BHC	0.044	0.331
B-BHC	0.139	0.002
G-BHC	0.116	0.011

CORRELATION OF LCIC CONCENTRATION WITH DISTANCE FROM NEAREST THE CANAL BOUNDARY

Chemical	Spearman Correlation (r)	p-value H_0: r=0
DCB	0.008	0.859
TCB	-0.056	0.208
TeCB	-0.075	0.092
CNP	0.079	0.086
A-BHC	-0.057	0.199
D-BHC	-0.141	0.002
B-BHC	-0.069	0.135
G-BHC	-0.074	0.094

This analysis gives very little evidence that LCIC concentrations decrease with increasing distance from the Love Canal. The analysis relating concentration level to distance from the center of the Canal gave no evidence of this relationship, with correlations that were either positive or indistinguishable from zero. The analysis based on distance from the boundary of the Canal gives some weak evidence of a negative relationship. However, even the one correlation that is significantly different from zero ($p<0.01$) is quite small. The high degree of statistical significance associated with the rejection of the zero correlation hypothesis for such small correlations is the result of the large sample size. As an example, a plot of G-BHC concentration versus distance from the Canal (Figure L-12) does not provide a convincing impression of a relationship between distance and concentration.

KRIGING ANALYSIS OF LCIC CONCENTRATIONS

One of the assumptions made in the statistical analysis of the soil chemistry data was that the data were independently distributed under the null hypothesis (no difference in soil chemistry between sampling areas and comparison areas). Essentially, this is equivalent to saying that the data have no spatial structure, for instance, the soil LCIC concentrations do not vary within a sampling or comparison area in such a way that knowledge of the concentration and location of a sample would allow prediction of the concentration of a nearby sample. Inspection of the sampling results and the site locator map given in Appendix I of Volume III of the final report suggests that this is a reasonable assumption. However, given the interest in possible spatial patterns in the soil chemistry results, a more detailed analysis was undertaken.

One common approach to the analysis of spatial data is random field theory, a special case of which is Kriging. Random field theory is discussed in a number of textbooks. The general idea is that the structure of a set of spatial data (that is, observations with which a spatial location, such as the sample site coordinates, can be associated) can be described in terms of a function known as the variogram, $\gamma(h)=E[Z(\underline{x}_1)-Z(\underline{x}_2)]^2$, where $h=||\underline{x}_1-\underline{x}_2||$. A best linear unbiased estimator of the value of the random field at any unmeasured location can be developed as a function of the known observations and $\gamma(h)$. In this form, the random field $Z(\underline{x})$ is assumed to be homogeneous and isotropic, that is, γ depends only on h and not on the orientation or specific location of the samples. More general formulations of the variogram are possible. For this exploratory analysis, however, an isotropic condition was assumed. In the special case of a stationary random field where the correlation between observations with separation distance h is $\rho(h)$, it can easily be shown that $\gamma(h)=\sigma^2[1-\rho(h)]$, where σ^2 is the variance of the random field. If the data have no spatial structure, that is, the observations are independent of the separation distance, the variogram is constant.

In addition to a stationary field, the variogram is applicable to a more general case where there is an underlying linear "drift" or trend surface. Because the variogram is based on a difference between observations and not their products, its estimator is not confounded by a first-order trend. A more general formulation, which uses a generalized covariance rather than the variogram, is applicable to cases in which the trend surface can be described by higher-order multinomials. One might question the implicit assumption of a linear trend surface, given the complexity of most spatial processes. In practice, though, it is only the behavior of the random function in a neighborhood containing the few nearest observations that is important. For the Love Canal soil sampling data, this is typically a few hundred feet.

Variograms were estimated for each of the LCICs within each sampling area (using the original sampling area designations described in Volume III of the Final Report). Variogram estimation is usually accomplished by separating data pairs into distance classes in such a way that there are enough pairs within each distance class to avoid excessive sampling variability. For n observations, there are no (n-1)/2 unique pairs, so even for a sample size of 50 there are over 1,000 pairs. For the Love Canal soil chemistry data, variogram estimation was complicated by the differences among laboratories, as discussed in the Volume III of the final report. Therefore, the following approach was taken. First, within a given area, the distances corresponding to each data pair (regardless of the laboratory that performed the analysis) were computed. Next, the 10th, 20th, ... 90th percentiles of the separation distances were computed. Then, for all samples collected by a given laboratory, the appropriate distance class was identified. Non-detect observations were replaced with a uniformly distributed random number in the range between zero and an assumed effective detection limit of 0.5 ppb (the use of a random distribution in place of the non-detectable values properly reflects lack of knowledge of the true value; use of any fixed value (for instance, zero or the detection limit), would bias the estimate of the variogram). In addition, the variogram estimation was performed on the logarithms of the observations, rather than the raw observations, to avoid giving disproportionate weight to the large observations. Finally, the sums of squares of differences in observations within each laboratory were computed and averaged to provide the variogram estimator,

$$\hat{\gamma}(h_i) = \frac{1}{n_i} \sum_{i=1}^{n_i} S_i^2$$

where S_i^2 is the squared difference associated with observation pair i. This variogram estimator was consistent with the earlier analysis in that observations collected by different laboratories were not compared directly. The number of observation pairs in each distance class was substantially reduced over what would have been available if across-laboratory comparisons could be made; however, it was still adequate for exploratory analysis. For most sampling areas, the number of observation pairs in each distance class ranged from 15 to 40. In cases where the number of observations in a distance class was less than 10, distance classes were aggregated until this minimum was achieved.

The results are shown in Figures L-13 through 20. Given the number of observation pairs in each distance class, virtually all the sample variograms suggest an absence of spatial structure (constant variogram). It should be noted that there is not a formal test to determine, for instance, whether the sample variogram is nonconstant. Therefore, the results must be viewed entirely as exploratory. Note that $\gamma(0)=0$ by definition, so no significance should be attached to the joining of $\gamma(0)$ and $\gamma(h_1)$.

Inspection of Figures L-13 through 20 indicates the following LCICs and areas for which the variogram is apparently not flat and for which there is some possible spatial structure:

- DCB: EDA5, EDA7, 221
- TCB: EDA2, EDA4, 221
- TeCB: EDA3, EDA4, 221
- 2-CNP: EDA7

- A-BHC: EDA2, 221
- B-BHC: EDA2
- D-BHC: 221
- G-BHC: EDA1, 221

Overall, only 16 of the 80 possible area-LCIC combinations showed any apparent spatial structure. It is of interest that of the 16, Census Tract 221, a comparison area, appeared six times. This suggests that there may be some smooth variation in the concentrations of many of the LCICs within Census Tract 221, but that for most of the EDA sampling areas the concentrations were more or less random, and the assumption of statistical independence is warranted.

Two comments should be made. First, all the observations are subject to measurement error. Because of the randomization in the experimental design, the measurement error should be statistically independent. Its effect is to dilute any spatial structure that might be present in the data. Second, the variogram analysis does not reflect the magnitude of the concentrations within a given area, nor were variations analyzed among sampling areas. It is clear, for instance, that Sampling Area (Neighborhood) 1 had substantially higher concentrations of most LCICs than did the other areas. The effect of the analysis is only to confirm that within Sampling Area 1, the observations were essentially random. Also, because the analysis was conducted within areas, the maximum separation distance class was limited to about 1,500 feet. If the analysis were conducted for all sampling areas simultaneously, some of the between-area differences detected using the Wilcoxon rank sum test might be reflected in the variogram shape at distances on the order of the typical distance among areas.

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Table L-1 LOVE CANAL CORRELATION ANALYSIS

```
                                                                                          8

VARIABLE      N          MEAN          STD DEV          MEDIAN        MINIMUM         MAXIMUM

CONC1       654    0.56125382       0.90064293      0.39000000            0     19.80000000
CONC2       683    1.98970717       7.83548659      0.57000000            0    167.33000000
CONC3       675    2.73677037      11.69210578      0.52000000            0    182.41000000
CONC4       639    0.05275430       0.05134786      0.05000000            0      0.32000000
CONC5       684    1.98288012      10.34717751      0.15000000            0    152.53000000
CONC6       672    0.36209821       3.50556707      0.00000000            0     79.99000000
CONC7       633   12.80699842     179.29544162      0.00000000            0   4108.31000000
CONC8       680    0.76722059       5.24521318      0.00000000            0     85.60000000

             SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

                         CONC1     CONC2     CONC3     CONC4     CONC5     CONC6     CONC7     CONC8

             CONC1     1.00000   0.48077   0.38408   0.22939   0.35283   0.24113   0.34725   0.25078
             DCB Conc   0.0000    0.0001    0.0001    0.0001    0.0001    0.0001    0.0001    0.0001
                           654       651       643       608       653       646       608       648

             CONC2     0.48077   1.00000   0.94244  -0.04135   0.75998   0.50081   0.62668   0.54945
             TCB Conc   0.0001    0.0000    0.0001    0.2977    0.0001    0.0001    0.0001    0.0001
                           651       683       672       636       681       669       630       677

             CONC3     0.38408   0.94244   1.00000  -0.06273   0.76969   0.52533   0.64084   0.56983
             QCB Conc   0.0001    0.0001    0.0000    0.1149    0.0001    0.0001    0.0001    0.0001
                           643       672       675       633       673       661       622       669

             CONC4     0.22939  -0.04135  -0.06273   1.00000   0.02362   0.07598  -0.01597   0.02768
             CN Conc    0.0001    0.2977    0.1149    0.0000    0.5515    0.0574    0.6997    0.4870
                           608       636       633       639       638       626       586       633

             CONC5     0.35283   0.75998   0.76969   0.02362   1.00000   0.53080   0.71231   0.62400
             A-BHC Conc 0.0001    0.0001    0.0001    0.5515    0.0000    0.0001    0.0001    0.0001
                           653       681       673       638       684       671       631       678

             CONC6     0.24113   0.50081   0.52533   0.07598   0.53080   1.00000   0.55897   0.55018
             D-BHC Conc 0.0001    0.0001    0.0001    0.0574    0.0001    0.0000    0.0001    0.0001
                           646       669       661       626       671       672       625       666

             CONC7     0.34725   0.62668   0.64084  -0.01597   0.71231   0.55897   1.00000   0.59500
             B-BHC Conc 0.0001    0.0001    0.0001    0.6997    0.0001    0.0001    0.0000    0.0001
                           608       630       622       586       631       625       633       631

             CONC8     0.25078   0.54945   0.56983   0.02768   0.62400   0.55018   0.59500   1.00000
             G-BHC Conc 0.0001    0.0001    0.0001    0.4870    0.0001    0.0001    0.0001    0.0000
                           648       677       669       633       678       666       631       680
```

Table L-2 LOVE CANAL CORRELATION ANALYSIS
LAB 1

```
VARIABLE      N             MEAN            STD DEV             MEDIAN          MINIMUM            MAXIMUM

CONC1        96       0.49333333         0.24556987         0.42000000                0         1.73000000
CONC2       117       1.05384615         1.52279113         0.52000000                0         8.86000000
CONC3       117       1.35282051         2.80981281         0.47000000                0        18.08000000
CONC4       117       0.08555556         0.03806629         0.09000000                0         0.17000000
CONC5       117       1.89393162        12.18321959         0.15000000                0       129.90000000
CONC6       117       0.12358974         0.33559895         0.00000000                0         2.08000000
CONC7       109      39.02220183       393.42723777         0.07000000                0      4108.31000000
CONC8       116       1.79758621        10.95619393         0.00000000                0        85.60000000


            SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

                         CONC1     CONC2     CONC3     CONC4     CONC5     CONC6     CONC7     CONC8

            CONC1      1.00000   0.72155   0.64582   0.41858   0.59263   0.53331   0.49668   0.40628
            DCB Conc    0.0000    0.0001    0.0001    0.0001    0.0001    0.0001    0.0001    0.0001
                            96        96        96        96        96        96        95        95

            CONC2      0.72155   1.00000   0.91819   0.25281   0.83011   0.62018   0.61181   0.65172
            TCB Conc    0.0001    0.0000    0.0001    0.0060    0.0001    0.0001    0.0001    0.0001
                            96       117       117       117       117       117       109       116

            CONC3      0.64582   0.91819   1.00000   0.20240   0.87650   0.63946   0.65465   0.72835
            QCB Conc    0.0001    0.0001    0.0000    0.0286    0.0001    0.0001    0.0001    0.0001
                            96       117       117       117       117       117       109       116

            CONC4      0.41858   0.25281   0.20240   1.00000   0.27219   0.34835   0.20593   0.30209
            CN Conc     0.0001    0.0060    0.0286    0.0000    0.0030    0.0001    0.0317    0.0010
                            96       117       117       117       117       117       109       116

            CONC5      0.59263   0.83011   0.87650   0.27219   1.00000   0.63827   0.73307   0.72480
            A-BHC Conc  0.0001    0.0001    0.0001    0.0030    0.0000    0.0001    0.0001    0.0001
                            96       117       117       117       117       117       109       116

            CONC6      0.53331   0.62018   0.63946   0.34835   0.63827   1.00000   0.62393   0.61863
            D-BHC Conc  0.0001    0.0001    0.0001    0.0001    0.0001    0.0000    0.0001    0.0001
                            96       117       117       117       117       117       109       116

            CONC7      0.49668   0.61181   0.65465   0.20593   0.73307   0.62393   1.00000   0.56275
            B-BHC Conc  0.0001    0.0001    0.0001    0.0317    0.0001    0.0001    0.0000    0.0001
                            95       109       109       109       109       109       109       108

            CONC8      0.40628   0.65172   0.72835   0.30209   0.72480   0.61863   0.56275   1.00000
            G-BHC Conc  0.0001    0.0001    0.0001    0.0010    0.0001    0.0001    0.0001    0.0000
                            95       116       116       116       116       116       108       116
```

Table L-3 LOVE CANAL CORRELATION ANALYSIS
LAB 8

RIABLE	N	MEAN	STD DEV	MEDIAN	MINIMUM	MAXIMUM
IC1	101	0.82089109	0.32880724	0.75000000	0.00000000	2.46000000
IC2	102	1.42068627	2.63586507	0.47500000	0.11000000	13.84000000
IC3	101	1.70663366	4.00550378	0.39000000	0.00000000	23.09000000
IC4	85	0.07152941	0.06142176	0.08000000	0.00000000	0.21000000
IC5	100	2.17540000	15.28452994	0.07000000	0.00000000	152.53000000
IC6	101	0.96930693	7.98427671	0.00000000	0.00000000	79.99000000
IC7	102	19.21294118	171.32464748	0.00000000	0.00000000	1729.10000000
IC8	102	1.05960784	5.37379614	0.00000000	0.00000000	47.05000000

SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	CONC1	CONC2	CONC3	CONC4	CONC5	CONC6	CONC7	CONC8
CONC1 DCB Conc	1.00000 0.0000 101	0.41565 0.0001 101	0.32644 0.0009 100	-0.11318 0.3024 85	0.22286 0.0258 100	0.19067 0.0561 101	0.17319 0.0833 101	0.33633 0.0006 101
CONC2 TCB Conc	0.41565 0.0001 101	1.00000 0.0000 102	0.94181 0.0001 101	-0.29922 0.0054 85	0.75993 0.0001 100	0.31703 0.0012 101	0.61528 0.0001 102	0.55087 0.0001 102
CONC3 QCB Conc	0.32644 0.0009 100	0.94181 0.0001 101	1.00000 0.0000 101	-0.41319 0.0001 85	0.73664 0.0001 99	0.36383 0.0002 100	0.65301 0.0001 101	0.54399 0.0001 101
CONC4 CN Conc	-0.11318 0.3024 85	-0.29922 0.0054 85	-0.41319 0.0001 85	1.00000 0.0000 85	-0.40779 0.0001 84	-0.28300 0.0087 85	-0.46155 0.0001 85	-0.34368 0.0013 85
CONC5 A-BHC Conc	0.22286 0.0258 100	0.75993 0.0001 100	0.73664 0.0001 99	-0.40779 0.0001 84	1.00000 0.0000 100	0.32961 0.0008 100	0.61439 0.0001 100	0.46767 0.0001 100
CONC6 D-BHC Conc	0.19067 0.0561 101	0.31703 0.0012 101	0.36383 0.0002 100	-0.28300 0.0087 85	0.32961 0.0008 100	1.00000 0.0000 101	0.29997 0.0023 101	0.35123 0.0003 101
CONC7 B-BHC Conc	0.17319 0.0833 101	0.61528 0.0001 102	0.65301 0.0001 101	-0.46155 0.0001 85	0.61439 0.0001 100	0.29997 0.0023 101	1.00000 0.0000 102	0.37746 0.0001 102
CONC8 G-BHC Conc	0.33633 0.0006 101	0.55087 0.0001 102	0.54399 0.0001 101	-0.34368 0.0013 85	0.46767 0.0001 100	0.35123 0.0003 101	0.37746 0.0001 102	1.00000 0.0000 102

Table L-4 LOVE CANAL CORRELATION ANALYSIS
LAB 2

VARIABLE	N	MEAN	STD DEV	MEDIAN	MINIMUM	MAXIMUM
CONC1	94	0.43861702	0.29342106	0.36000000	0.17000000	2.68000000
CONC2	104	1.21461538	2.87207341	0.47000000	0.08000000	24.82000000
CONC3	103	1.74728155	5.38747480	0.44000000	0.00000000	44.23000000
CONC4	100	0.03550000	0.04207677	0.00000000	0.00000000	0.14000000
CONC5	104	1.05125000	3.45365732	0.15000000	0.00000000	24.65000000
CONC6	99	0.09383838	0.35518523	0.00000000	0.00000000	1.93000000
CONC7	94	0.96957447	3.49958244	0.00000000	0.00000000	24.39000000
CONC8	104	0.23221154	0.77694067	0.00000000	0.00000000	4.80000000

SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	CONC1	CONC2	CONC3	CONC4	CONC5	CONC6	CONC7	CONC8
CONC1 DCB Conc	1.00000 0.0000 94	0.51689 0.0001 94	0.44528 0.0001 93	0.28385 0.0067 90	0.43708 0.0001 94	0.38955 0.0001 94	0.30573 0.0047 84	0.49548 0.0001 94
CONC2 TCB Conc	0.51689 0.0001 94	1.00000 0.0000 104	0.94997 0.0001 103	0.05758 0.5694 100	0.74530 0.0001 104	0.48783 0.0001 99	0.52582 0.0001 94	0.63436 0.0001 104
CONC3 QCB Conc	0.44528 0.0001 93	0.94997 0.0001 103	1.00000 0.0000 103	0.01751 0.8635 99	0.73863 0.0001 103	0.48395 0.0001 98	0.51952 0.0001 93	0.63355 0.0001 103
CONC4 CN Conc	0.28385 0.0067 90	0.05758 0.5694 100	0.01751 0.8635 99	1.00000 0.0000 100	0.16149 0.1085 100	0.05886 0.5710 95	0.05451 0.6099 90	0.06487 0.5214 100
CONC5 A-BHC Conc	0.43708 0.0001 94	0.74530 0.0001 104	0.73863 0.0001 103	0.16149 0.1085 100	1.00000 0.0000 104	0.49768 0.0001 99	0.68093 0.0001 94	0.67242 0.0001 104
CONC6 D-BHC Conc	0.38955 0.0001 94	0.48783 0.0001 99	0.48395 0.0001 98	0.05886 0.5710 95	0.49768 0.0001 99	1.00000 0.0000 99	0.59309 0.0001 89	0.62871 0.0001 99
CONC7 B-BHC Conc	0.30573 0.0047 84	0.52582 0.0001 94	0.51952 0.0001 93	0.05451 0.6099 90	0.68093 0.0001 94	0.59309 0.0001 89	1.00000 0.0000 94	0.68069 0.0001 94
CONC8 G-BHC Conc	0.49548 0.0001 94	0.63436 0.0001 104	0.63355 0.0001 103	0.06487 0.5214 100	0.67242 0.0001 104	0.62871 0.0001 99	0.68069 0.0001 94	1.00000 0.0000 104

Table L-5 LOVE CANAL CORRELATION ANALYSIS
LAB 6

ABLE	N	MEAN	STD DEV	MEDIAN	MINIMUM	MAXIMUM
1	128	0.52367187	0.66252187	0.35000000	0.00000000	4.84000000
2	127	2.48574803	6.68724307	0.78000000	0.08000000	52.60000000
3	128	4.40953125	17.53058151	0.81500000	0.00000000	168.64000000
4	128	0.02375000	0.03236115	0.00000000	0.00000000	0.24000000
5	128	2.15093750	9.30755822	0.20500000	0.00000000	83.51000000
6	128	0.30421875	1.03499219	0.00000000	0.00000000	9.96000000
7	109	8.60247706	64.17857659	0.11000000	0.00000000	663.49000000
8	127	0.59622047	2.73889792	0.00000000	0.00000000	26.33000000

SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	CONC1	CONC2	CONC3	CONC4	CONC5	CONC6	CONC7	CONC8
CONC1 DCB Conc	1.00000 0.0000 128	0.65876 0.0001 127	0.63760 0.0001 128	0.16333 0.0655 128	0.51815 0.0001 128	0.40710 0.0001 128	0.62048 0.0001 109	0.22467 0.0111 127
CONC2 TCB Conc	0.65876 0.0001 127	1.00000 0.0000 127	0.96686 0.0001 127	0.03890 0.6641 127	0.82953 0.0001 127	0.63725 0.0001 127	0.78617 0.0001 108	0.53425 0.0001 126
CONC3 QCB Conc	0.63760 0.0001 128	0.96686 0.0001 127	1.00000 0.0000 128	0.03559 0.6901 128	0.79648 0.0001 128	0.60352 0.0001 128	0.76112 0.0001 109	0.51273 0.0001 127
CONC4 CN Conc	0.16333 0.0655 128	0.03890 0.6641 127	0.03559 0.6901 128	1.00000 0.0000 128	0.08028 0.3677 128	0.04737 0.5954 128	0.02986 0.7579 109	-0.09959 0.2653 127
CONC5 A-BHC Conc	0.51815 0.0001 128	0.82953 0.0001 127	0.79648 0.0001 128	0.08028 0.3677 128	1.00000 0.0000 128	0.69902 0.0001 128	0.82641 0.0001 109	0.61108 0.0001 127
CONC6 D-BHC Conc	0.40710 0.0001 128	0.63725 0.0001 127	0.60352 0.0001 128	0.04737 0.5954 128	0.69902 0.0001 128	1.00000 0.0000 128	0.73957 0.0001 109	0.57162 0.0001 127
CONC7 B-BHC Conc	0.62048 0.0001 109	0.78617 0.0001 108	0.76112 0.0001 109	0.02986 0.7579 109	0.82641 0.0001 109	0.73957 0.0001 109	1.00000 0.0000 109	0.61304 0.0001 108
CONC8 G-BHC Conc	0.22467 0.0111 127	0.53425 0.0001 126	0.51273 0.0001 127	-0.09959 0.2653 127	0.61108 0.0001 127	0.57162 0.0001 127	0.61304 0.0001 108	1.00000 0.0000 127

Table L-6 LOVE CANAL CORRELATION ANALYSIS
LAB 7

```
VARIABLE     N            MEAN          STD DEV          MEDIAN          MINIMUM          MAXIMUM

CONC1      107      0.42392523       0.47226024      0.31000000       0.00000000       4.22000000
CONC2      106      2.01358491       5.74417306      0.46000000       0.07000000      41.74000000
CONC3      105      3.16266667       9.47963934      0.47000000       0.00000000      64.25000000
CONC4       93      0.07645161       0.05625341      0.07000000       0.00000000       0.32000000
CONC5      107      1.69915888       5.90383568      0.13000000       0.00000000      35.09000000
CONC6      101      0.58188119       3.91645394      0.00000000       0.00000000      38.83000000
CONC7       96      3.33312500      11.04027691      0.00000000       0.00000000      55.51000000
CONC8      107      0.45504673       2.00440052      0.00000000       0.00000000      15.83000000

        SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

                  CONC1     CONC2     CONC3     CONC4     CONC5     CONC6     CONC7     CONC8

CONC1           1.00000   0.54321   0.49249   0.54622   0.50844   0.36157   0.44974   0.33235
DCB Conc         0.0000    0.0001    0.0001    0.0001    0.0001    0.0002    0.0001    0.0005
                    107       106       105        93       107       101        96       107

CONC2           0.54321   1.00000   0.92997   0.21236   0.78678   0.62983   0.65087   0.49332
TCB Conc         0.0001    0.0000    0.0001    0.0421    0.0001    0.0001    0.0001    0.0001
                    106       106       104        92       106       100        95       106

CONC3           0.49249   0.92997   1.00000   0.19920   0.77368   0.65294   0.65440   0.50774
QCB Conc         0.0001    0.0001    0.0000    0.0556    0.0001    0.0001    0.0001    0.0001
                    105       104       105        93       105        99        94       105

CONC4           0.54622   0.21236   0.19920   1.00000   0.22144   0.13508   0.17892   0.06112
CN Conc          0.0001    0.0421    0.0556    0.0000    0.0329    0.2122    0.1078    0.5606
                     93        92        93        93        93        87        82        93

CONC5           0.50844   0.78678   0.77368   0.22144   1.00000   0.61391   0.75618   0.63180
A-BHC Conc       0.0001    0.0001    0.0001    0.0329    0.0000    0.0001    0.0001    0.0001
                    107       106       105        93       107       101        96       107

CONC6           0.36157   0.62983   0.65294   0.13508   0.61391   1.00000   0.61862   0.59230
D-BHC Conc       0.0002    0.0001    0.0001    0.2122    0.0001    0.0000    0.0001    0.0001
                    101       100        99        87       101       101        96       101

CONC7           0.44974   0.65087   0.65440   0.17892   0.75618   0.61862   1.00000   0.64504
B-BHC Conc       0.0001    0.0001    0.0001    0.1078    0.0001    0.0001    0.0000    0.0001
                     96        95        94        82        96        96        96        96

CONC8           0.33235   0.49332   0.50774   0.06112   0.63180   0.59230   0.64504   1.00000
G-BHC Conc       0.0005    0.0001    0.0001    0.5606    0.0001    0.0001    0.0001    0.0000
                    107       106       105        93       107       101        96       107
```

Table L-7 LOVE CANAL CORRELATION ANALYSIS
LAB 4

ABLE	N	MEAN	STD DEV	MEDIAN	MINIMUM	MAXIMUM
1	20	0.43750000	0.52776465	0.27500000	0.16000000	2.47000000
2	20	2.82150000	6.45622121	0.38000000	0.13000000	24.02000000
3	17	5.12352941	12.79056681	0.43000000	0.04000000	50.20000000
4	20	0.07800000	0.03819617	0.08000000	0.00000000	0.17000000
5	20	5.54400000	15.85198457	0.00000000	0.00000000	69.70000000
6	20	0.82100000	2.25276181	0.00000000	0.00000000	9.83000000
7	20	17.02000000	55.23798016	0.18500000	0.00000000	241.25000000
8	20	1.16100000	2.95461441	0.01500000	0.00000000	12.20000000

SPEARMAN CORRELATION COEFFICIENTS / PROB > \|R\| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	CONC1	CONC2	CONC3	CONC4	CONC5	CONC6	CONC7	CONC8
CONC1 DCB Conc	1.00000 0.0000 20	0.78864 0.0001 20	0.83806 0.0001 17	0.52005 0.0188 20	0.58592 0.0066 20	0.47773 0.0331 20	0.60191 0.0050 20	0.52210 0.0182 20
CONC2 TCB Conc	0.78864 0.0001 20	1.00000 0.0000 20	0.99202 0.0001 17	0.26612 0.2568 20	0.83055 0.0001 20	0.72602 0.0003 20	0.89753 0.0001 20	0.85092 0.0001 20
CONC3 QCB Conc	0.83806 0.0001 17	0.99202 0.0001 17	1.00000 0.0000 17	0.23828 0.3571 17	0.85986 0.0001 17	0.72844 0.0009 17	0.85587 0.0001 17	0.85986 0.0001 17
CONC4 CN Conc	0.52005 0.0188 20	0.26612 0.2568 20	0.23828 0.3571 17	1.00000 0.0000 20	0.08538 0.7204 20	0.27813 0.2351 20	0.17797 0.4528 20	0.06716 0.7785 20
CONC5 A-BHC Conc	0.58592 0.0066 20	0.83055 0.0001 20	0.85986 0.0001 17	0.08538 0.7204 20	1.00000 0.0000 20	0.86335 0.0001 20	0.88969 0.0001 20	0.97611 0.0001 20
CONC6 D-BHC Conc	0.47773 0.0331 20	0.72602 0.0003 20	0.72844 0.0009 17	0.27813 0.2351 20	0.86335 0.0001 20	1.00000 0.0000 20	0.80587 0.0001 20	0.84273 0.0001 20
CONC7 B-BHC Conc	0.60191 0.0050 20	0.89753 0.0001 20	0.85587 0.0001 17	0.17797 0.4528 20	0.88969 0.0001 20	0.80587 0.0001 20	1.00000 0.0000 20	0.91933 0.0001 20
CONC8 G-BHC Conc	0.52210 0.0182 20	0.85092 0.0001 20	0.85986 0.0001 17	0.06716 0.7785 20	0.97611 0.0001 20	0.84273 0.0001 20	0.91933 0.0001 20	1.00000 0.0000 20

Table L-8 LOVE CANAL CORRELATION ANALYSIS

LAB 3

```
VARIABLE     N            MEAN          STD DEV           MEDIAN          MINIMUM          MAXIMUM

CONC1      108      0.68907407       1.95157714       0.38000000       0.00000000      19.80000000
CONC2      107      3.54093458      16.72734105       0.87000000       0.04000000     167.33000000
CONC3      104      3.39519231      18.35840164       0.68000000       0.00000000     182.41000000
CONC4       96      0.02458333       0.03777821       0.00000000       0.00000000       0.17000000
CONC5      108      2.22055556      10.46227427       0.13500000       0.00000000     100.31000000
CONC6      106      0.07122642       0.30532950       0.00000000       0.00000000       2.04000000
CONC7      103      1.98543689       6.79504127       0.00000000       0.00000000      44.89000000
CONC8      104      0.32048077       1.25041770       0.00000000       0.00000000       9.53000000

SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

                 CONC1     CONC2     CONC3     CONC4     CONC5     CONC6     CONC7     CONC8

CONC1          1.00000   0.75902   0.59222  -0.00318   0.45183   0.14995   0.43503   0.30731
DCB Conc        0.0000    0.0001    0.0001    0.9755    0.0001    0.1250    0.0001    0.0015
                   108       107       104        96       108       106       103       104

CONC2          0.75902   1.00000   0.91393  -0.02426   0.64143   0.30281   0.57702   0.51064
TCB Conc        0.0001    0.0000    0.0001    0.8155    0.0001    0.0017    0.0001    0.0001
                   107       107       103        95       107       105       102       103

CONC3          0.59222   0.91393   1.00000  -0.01790   0.64791   0.31411   0.56465   0.48510
QCB Conc        0.0001    0.0001    0.0000    0.8640    0.0001    0.0013    0.0001    0.0001
                   104       103       104        94       104       102        99       100

CONC4         -0.00318  -0.02426  -0.01790   1.00000   0.07518  -0.05288  -0.09122  -0.00750
CN Conc         0.9755    0.8155    0.8640    0.0000    0.4666    0.6127    0.3898    0.9434
                    96        95        94        96        96        94        91        92

CONC5          0.45183   0.64143   0.64791   0.07518   1.00000   0.21661   0.64382   0.57433
A-BHC Conc      0.0001    0.0001    0.0001    0.4666    0.0000    0.0257    0.0001    0.0001
                   108       107       104        96       108       106       103       104

CONC6          0.14995   0.30281   0.31411  -0.05288   0.21661   1.00000   0.29954   0.32670
D-BHC Conc      0.1250    0.0017    0.0013    0.6127    0.0257    0.0000    0.0023    0.0008
                   106       105       102        94       106       106       101       102

CONC7          0.43503   0.57702   0.56465  -0.09122   0.64382   0.29954   1.00000   0.61180
B-BHC Conc      0.0001    0.0001    0.0001    0.3898    0.0001    0.0023    0.0000    0.0001
                   103       102        99        91       103       101       103       103

CONC8          0.30731   0.51064   0.48510  -0.00750   0.57433   0.32670   0.61180   1.00000
G-BHC Conc      0.0015    0.0001    0.0001    0.9434    0.0001    0.0008    0.0001    0.0000
                   104       103       100        92       104       102       103       104
```

Table L-9 LOVE CANAL CORRELATION ANALYSIS
EDA ONLY

VARIABLE	N	MEAN	STD DEV	MEDIAN	MINIMUM	MAXIMUM
CONC1	488	0.59290984	1.03001990	0.39500000	0	19.80000000
CONC2	510	2.34939216	8.85880155	0.64000000	0	167.33000000
CONC3	502	3.30209163	13.16388954	0.61000000	0	182.41000000
CONC4	473	0.05124736	0.05015155	0.05000000	0	0.24000000
CONC5	509	2.51029470	11.84650271	0.18000000	0	152.53000000
CONC6	499	0.46935872	4.05610042	0.00000000	0	79.99000000
CONC7	470	16.97814894	207.94620076	0.00000000	0	4108.31000000
CONC8	507	0.81497041	4.85880694	0.00000000	0	85.60000000

SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / NUMBER OF OBSERVATIONS

	CONC1	CONC2	CONC3	CONC4	CONC5	CONC6	CONC7	CONC8
CONC1 DCB Conc	1.00000 0.0000 488	0.54411 0.0001 487	0.44546 0.0001 479	0.19218 0.0001 451	0.42286 0.0001 487	0.28125 0.0001 482	0.42286 0.0001 452	0.29783 0.0001 484
CONC2 TCB Conc	0.54411 0.0001 487	1.00000 0.0000 510	0.93407 0.0001 501	-0.07298 0.1133 472	0.77341 0.0001 508	0.52413 0.0001 498	0.65782 0.0001 469	0.57425 0.0001 506
CONC3 QCB Conc	0.44546 0.0001 479	0.93407 0.0001 501	1.00000 0.0000 502	-0.10021 0.0302 468	0.77586 0.0001 500	0.53976 0.0001 490	0.66173 0.0001 461	0.58580 0.0001 498
CONC4 CN Conc	0.19218 0.0001 451	-0.07298 0.1133 472	-0.10021 0.0302 468	1.00000 0.0000 473	-0.01011 0.8267 472	0.06600 0.1567 462	-0.02941 0.5421 432	-0.01048 0.8209 469
CONC5 A-BHC Conc	0.42286 0.0001 487	0.77341 0.0001 508	0.77586 0.0001 500	-0.01011 0.8267 472	1.00000 0.0000 509	0.54250 0.0001 498	0.74655 0.0001 468	0.64676 0.0001 505
CONC6 D-BHC Conc	0.28125 0.0001 482	0.52413 0.0001 498	0.53976 0.0001 490	0.06600 0.1567 462	0.54250 0.0001 498	1.00000 0.0000 499	0.56232 0.0001 463	0.53715 0.0001 495
CONC7 B-BHC Conc	0.42286 0.0001 452	0.65782 0.0001 469	0.66173 0.0001 461	-0.02941 0.5421 432	0.74655 0.0001 468	0.56232 0.0001 463	1.00000 0.0000 470	0.61751 0.0001 469
CONC8 G-BHC Conc	0.29783 0.0001 484	0.57425 0.0001 506	0.58580 0.0001 498	-0.01048 0.8209 469	0.64676 0.0001 505	0.53715 0.0001 495	0.61751 0.0001 469	1.00000 0.0000 507

Table L-10 LOVE CANAL CORRELATION ANALYSIS
BUFFALO COMPARISON AREA

```
VARIABLE     N          MEAN          STD DEV          MEDIAN          MINIMUM          MAXIMUM

CONC1       57    0.44807018       0.28395446      0.36000000       0.11000000       1.38000000
CONC2       60    0.16950000       0.13029855      0.13500000       0.07000000       0.92000000
CONC3       61    0.06786885       0.11187962      0.05000000       0.00000000       0.84000000
CONC4       54    0.04222222       0.04772827      0.03000000       0.00000000       0.21000000
CONC5       61    0.00442623       0.02446253      0.00000000       0.00000000       0.17000000
CONC6       61    0.00000000       0.00000000      0.00000000       0.00000000       0.00000000
CONC7       59    0.09694915       0.69857800      0.00000000       0.00000000       5.36000000
CONC8       59    0.00067797       0.00520756      0.00000000       0.00000000       0.04000000


SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

                CONC1     CONC2     CONC3     CONC4     CONC5     CONC6     CONC7     CONC8


CONC1         1.00000   0.61722   0.25871   0.32103   0.12136     .       0.04896   0.05574
DCB Conc       0.0000    0.0001    0.0520    0.0230    0.3685              0.7226    0.6860
                   57        56        57        50        57        57        55        55

CONC2         0.61722   1.00000   0.63094  -0.08586   0.10591     .       0.06063  -0.01190
TCB Conc       0.0001    0.0000    0.0001    0.5410    0.4206              0.6512    0.9294
                   56        60        60        53        60        60        58        58

CONC3         0.25871   0.63094   1.00000   0.01290   0.04745     .       0.06221   0.00389
QCB Conc       0.0520    0.0001    0.0000    0.9263    0.7165              0.6397    0.9767
                   57        60        61        54        61        61        59        59

CONC4         0.32103  -0.08586   0.01290   1.00000   0.02291     .       0.00400   0.16996
CN Conc        0.0230    0.5410    0.9263    0.0000    0.8694              0.9775    0.2284
                   50        53        54        54        54        54        52        52

CONC5         0.12136   0.10591   0.04745   0.02291   1.00000     .       0.38974  -0.03038
A-BHC Conc     0.3685    0.4206    0.7165    0.8694    0.0000              0.0023    0.8193
                   57        60        61        54        61        61        59        59

CONC6            .         .         .         .         .      1.00000     .         .
D-BHC Conc                                                         0.0000
                   57        60        61        54        61        61        59        59

CONC7         0.04896   0.06063   0.06221   0.00400   0.38974     .       1.00000  -0.02503
B-BHC Conc     0.7226    0.6512    0.6397    0.9775    0.0023              0.0000    0.8521
                   55        58        59        52        59        59        59        58

CONC8         0.05574  -0.01190   0.00389   0.16996  -0.03038     .      -0.02503   1.00000
G-BHC Conc     0.6860    0.9294    0.9767    0.2284    0.8193              0.8521    0.0000
                   55        58        59        52        59        59        58        59
```

Table L-11 LOVE CANAL CORRELATION ANALYSIS
CENSUS TRACT 221 COMPARISON AREA

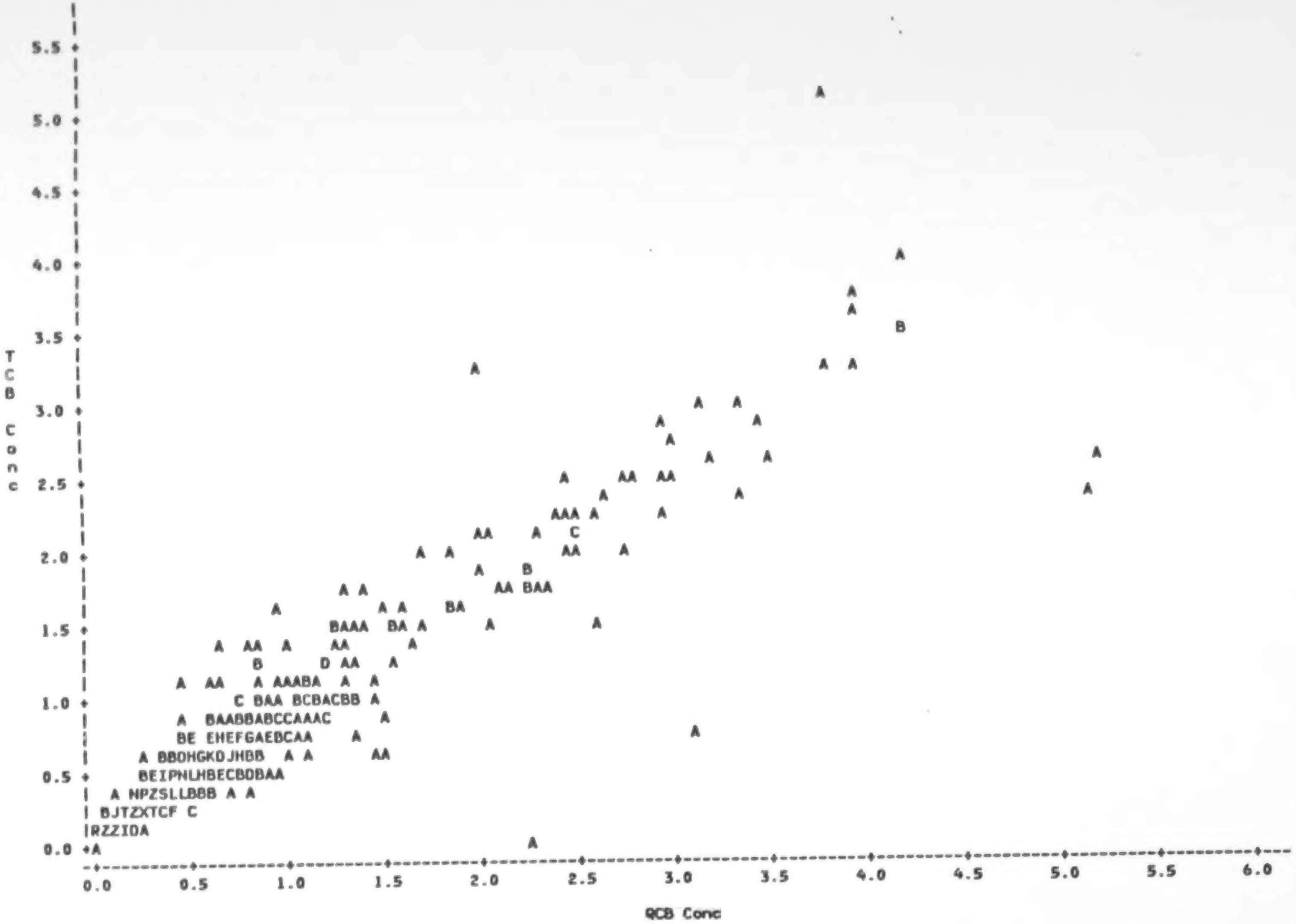
ABLE	N	MEAN	STD DEV	MEDIAN	MINIMUM	MAXIMUM
1	50	0.45320000	0.22515700	0.39000000	0.19000000	1.15000000
2	53	0.77377358	0.52141902	0.65000000	0.25000000	3.12000000
3	52	0.58557692	0.26411831	0.53000000	0.22000000	1.33000000
4	51	0.06156863	0.05485882	0.06000000	0.00000000	0.22000000
5	53	0.20867925	0.21730905	0.18000000	0.00000000	1.19000000
6	52	0.02615385	0.13619700	0.00000000	0.00000000	0.94000000
7	49	0.11183673	0.24001453	0.00000000	0.00000000	1.03000000
8	53	1.56415094	11.09518268	0.00000000	0.00000000	80.81000000

SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	CONC1	CONC2	CONC3	CONC4	CONC5	CONC6	CONC7	CONC8
CONC1 DCB Conc	1.00000 0.0000 50	0.45846 0.0008 50	0.29713 0.0331 49	0.39256 0.0058 48	0.19688 0.1706 50	0.00968 0.9474 49	0.04220 0.7807 46	0.01222 0.9329 50
CONC2 TCB Conc	0.45846 0.0008 50	1.00000 0.0000 53	0.89487 0.0001 52	-0.28646 0.0416 51	0.53882 0.0001 53	0.04723 0.7395 52	0.24249 0.0932 49	0.06631 0.6371 53
CONC3 QCB Conc	0.29713 0.0381 49	0.89487 0.0001 52	1.00000 0.0000 52	-0.28957 0.0393 51	0.55730 0.0001 52	0.20600 0.1470 51	0.28393 0.0505 48	0.07371 0.6036 52
CONC4 CN Conc	0.39256 0.0058 48	-0.28646 0.0416 51	-0.28957 0.0393 51	1.00000 0.0000 51	-0.16195 0.2562 51	0.04294 0.7671 50	-0.20043 0.1767 47	0.25338 0.0728 51
CONC5 A-BHC Conc	0.19688 0.1706 50	0.53882 0.0001 53	0.55730 0.0001 52	-0.16195 0.2562 51	1.00000 0.0000 53	0.16077 0.2549 52	0.36954 0.0090 49	0.22553 0.1044 53
CONC6 D-BHC Conc	0.00968 0.9474 49	0.04723 0.7395 52	0.20600 0.1470 51	0.04294 0.7671 50	0.16077 0.2549 52	1.00000 0.0000 52	0.49012 0.0004 49	0.10012 0.4801 52
CONC7 B-BHC Conc	0.04220 0.7807 46	0.24249 0.0932 49	0.28393 0.0505 48	-0.20043 0.1767 47	0.36954 0.0090 49	0.49012 0.0004 49	1.00000 0.0000 49	0.21454 0.1388 49
CONC8 G-BHC Conc	0.01222 0.9329 50	0.06631 0.6371 53	0.07371 0.6036 52	0.25338 0.0728 51	0.22553 0.1044 53	0.10012 0.4801 52	0.21454 0.1388 49	1.00000 0.0000 53

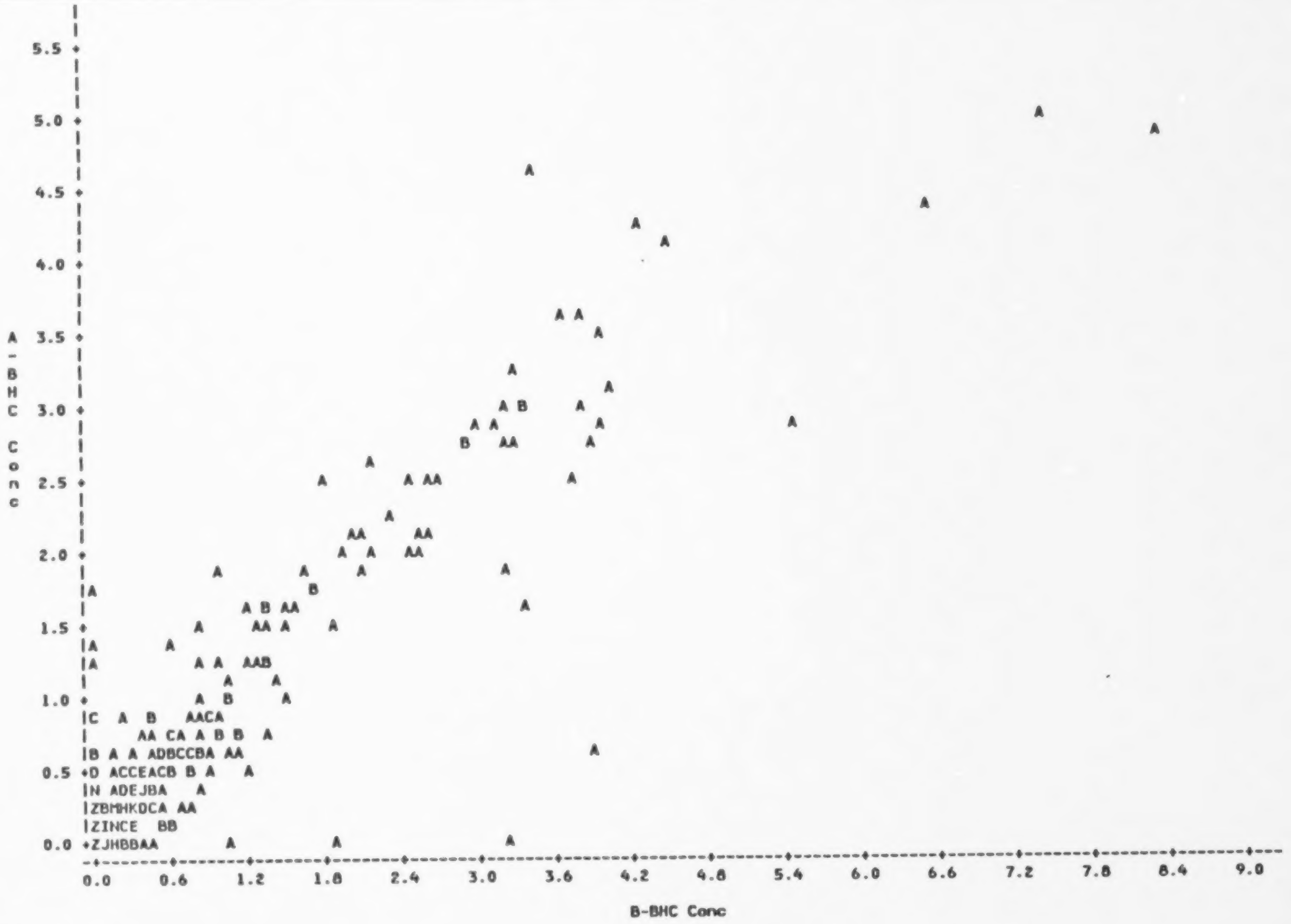
Table L-12 LOVE CANAL CORRELATION ANALYSIS
CENSUS TRACT 225 COMPARISON AREA

```
VARIABLE     N          MEAN            STD DEV          MEDIAN          MINIMUM           MAXIMUM

CONC1       59       0.50033898      0.26216582      0.43000000      0.18000000       1.40000000
CONC2       60       1.82666667      5.15182366      0.60500000      0.12000000      33.07000000
CONC3       60       2.58466667      8.71472890      0.62500000      0.06000000      64.25000000
CONC4       61       0.06639344      0.05793769      0.07000000      0.00000000       0.32000000
CONC5       61       1.10196721      4.53728914      0.11000000      0.00000000      33.97000000
CONC6       60       0.12933333      0.70161525      0.00000000      0.00000000       5.40000000
CONC7       55       2.10727273      9.18768912      0.00000000      0.00000000      50.57000000
CONC8       61       0.41934426      2.06940963      0.00000000      0.00000000      15.83000000

            SPEARMAN CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

                          CONC1     CONC2     CONC3     CONC4     CONC5     CONC6     CONC7     CONC8

            CONC1       1.00000   0.36374   0.34417   0.23062   0.16323   0.14308   0.13839   0.14490
            DCB Conc     0.0000    0.0050    0.0082    0.0789    0.2167    0.2840    0.3136    0.2735
                             59        58        58        59        59        58        55        59

            CONC2       0.36374   1.00000   0.93863   0.01355   0.52374   0.42648   0.45435   0.50298
            TCB Conc     0.0050    0.0000    0.0001    0.9182    0.0001    0.0008    0.0006    0.0001
                             58        60        59        60        60        59        54        60

            CONC3       0.34417   0.93863   1.00000  -0.03954   0.55685   0.45365   0.49776   0.55258
            QCB Conc     0.0082    0.0001    0.0000    0.7642    0.0001    0.0003    0.0001    0.0001
                             58        59        60        60        60        59        54        60

            CONC4       0.23062   0.01355  -0.03954   1.00000   0.20727   0.23532   0.06134   0.11294
            CN Conc      0.0789    0.9182    0.7642    0.0000    0.1090    0.0703    0.6564    0.3862
                             59        60        60        61        61        60        55        61

            CONC5       0.16323   0.52374   0.55685   0.20727   1.00000   0.51500   0.63398   0.59011
            A-BHC Conc   0.2167    0.0001    0.0001    0.1090    0.0000    0.0001    0.0001    0.0001
                             59        60        60        61        61        60        55        61

            CONC6       0.14308   0.42648   0.45365   0.23532   0.51500   1.00000   0.46609   0.72293
            D-BHC Conc   0.2840    0.0008    0.0003    0.0703    0.0001    0.0000    0.0004    0.0001
                             58        59        59        60        60        60        54        60

            CONC7       0.13839   0.45435   0.49776   0.06134   0.63398   0.46609   1.00000   0.53048
            B-BHC Conc   0.3136    0.0006    0.0001    0.6564    0.0001    0.0004    0.0000    0.0001
                             55        54        54        55        55        54        55        55

            CONC8       0.14490   0.50298   0.55258   0.11294   0.59011   0.72293   0.53048   1.00000
            G-BHC Conc   0.2735    0.0001    0.0001    0.3862    0.0001    0.0001    0.0001    0.0000
                             59        60        60        61        61        60        55        61
```



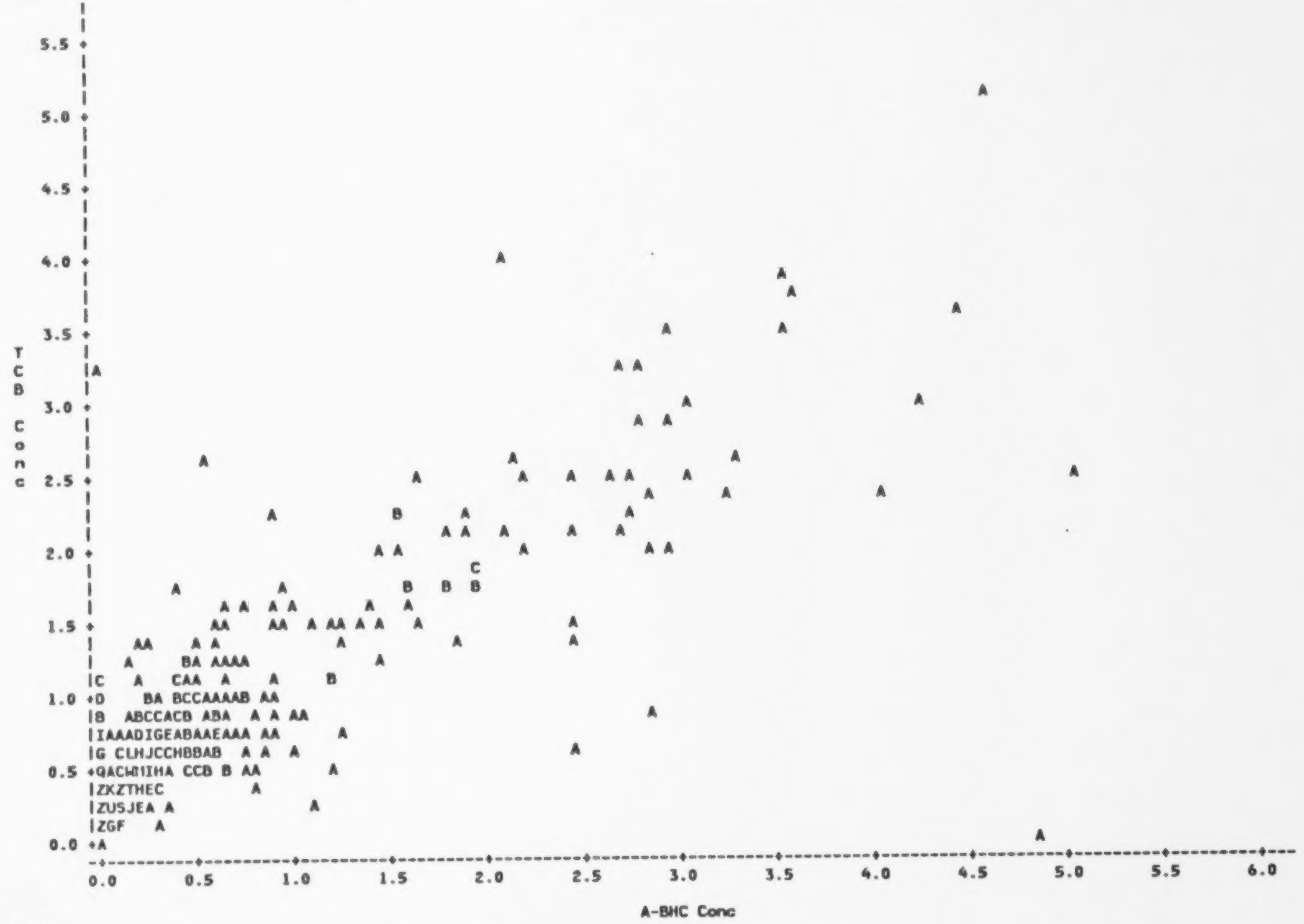
NOTES:
- A = 1 observation, B = 2 observations, etc.
- For 64 of the samples, one of the two chemicals plotted had no valid results, and the results for those samples are not shown
- 15 sample results are not shown because more than 26 samples (Z = 26) had the same coordinate concentrations.

Figure L-1 LOG CONCENTRATION OF 1,2,4,-TRICHLOROBENZENE VS. LOG CONCENTRATION OF 1,2,3,4-TETRACHLOROBENZENE



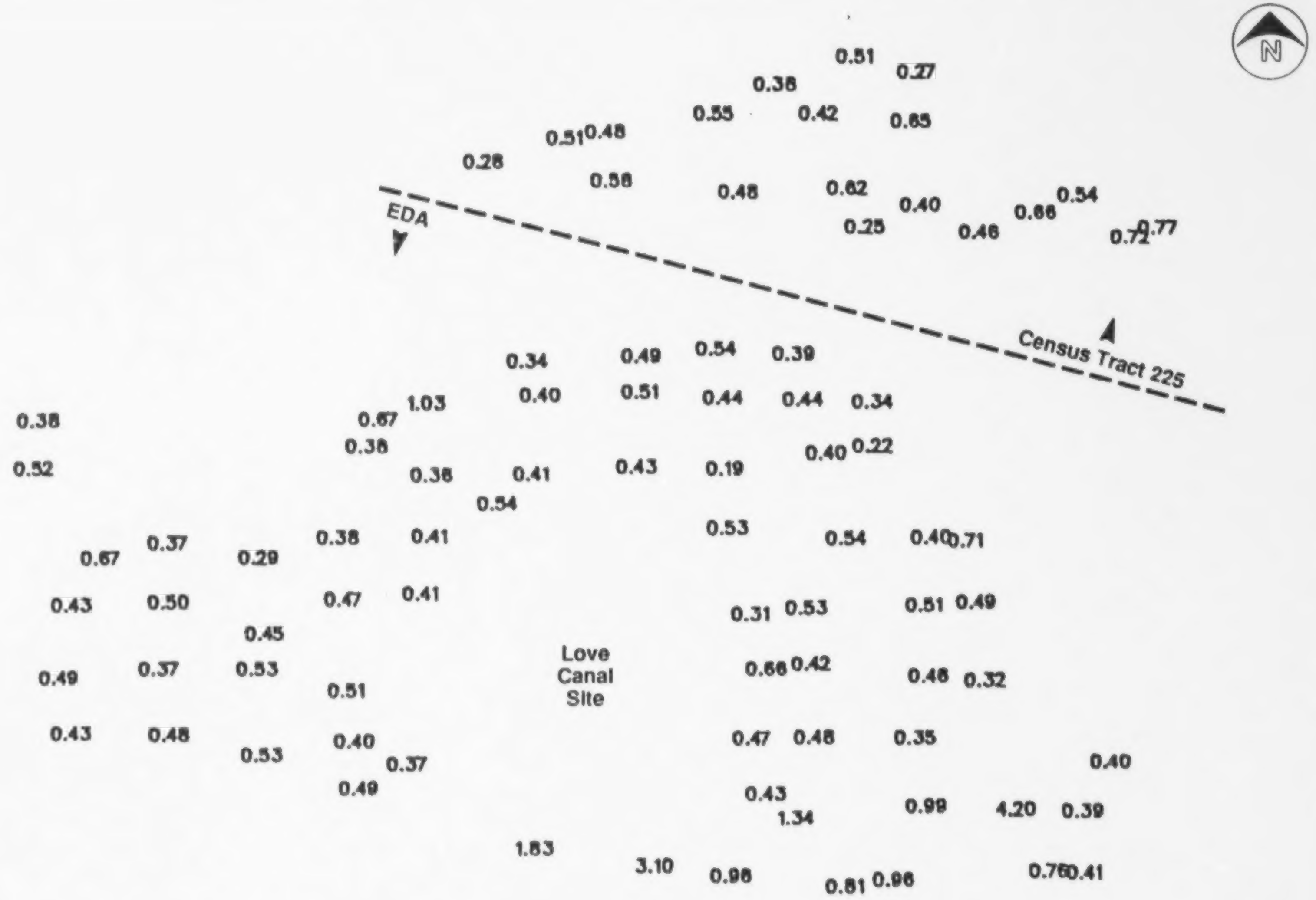
NOTES:
- A = 1 observation, B = 2 observations, etc.
- For 105 of the samples, one of the two chemicals plotted had no valid results, and the results for those samples are not shown.
- 264 sample results are not shown because more than 26 samples (Z = 26) had the same coordinate concentrations.

Figure L-2 LOG CONCENTRATION OF ALPHA-BHC VS. LOG CONCENTRATION OF BETA-BHC



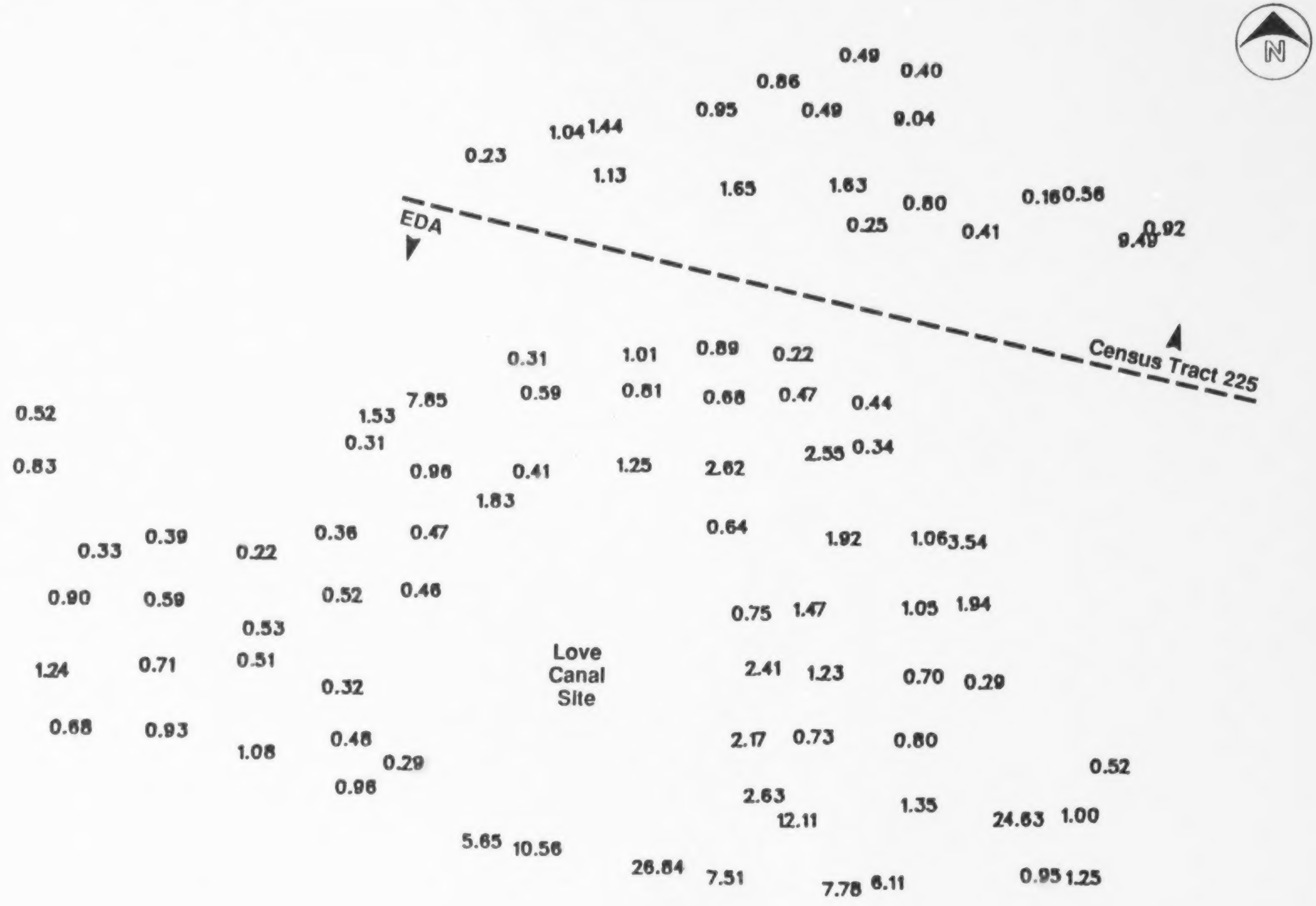
NOTES:
- A = 1 observation, B = 2 observations, etc.
- For 55 of the samples, one of the two chemicals plotted had no valid results, and the results for those samples are not shown.
- 101 sample results are not shown because more than 26 samples (Z = 26) had the same coordinate concentrations.

Figure L-3 LOG CONCENTRATION OF 1,2,4-TRICHLOROBENZENE VS. LOG CONCENTRATION OF ALPHA-BHC


N
0.51
0.27
0.38
0.55
0.42
0.65
0.51
0.48
0.28
0.58
0.48
0.62
0.40
0.54
0.66
0.25
0.46
0.72
0.77
EDA
Census Tract 225
0.34
0.49
0.54
0.39
1.03
0.40
0.51
0.44
0.44
0.34
0.38
0.67
0.38
0.40
0.22
0.52
0.38
0.41
0.43
0.19
0.54
0.53
0.37
0.38
0.41
0.54
0.40
0.71
0.67
0.29
0.43
0.50
0.47
0.41
0.31
0.53
0.51
0.49
0.45
Love
Canal
Site
0.49
0.37
0.53
0.51
0.66
0.42
0.46
0.32
0.43
0.48
0.53
0.40
0.47
0.48
0.35
0.37
0.40
0.49
0.43
1.34
0.99
4.20
0.39
1.83
3.10
0.98
0.81
0.96
0.76
0.41

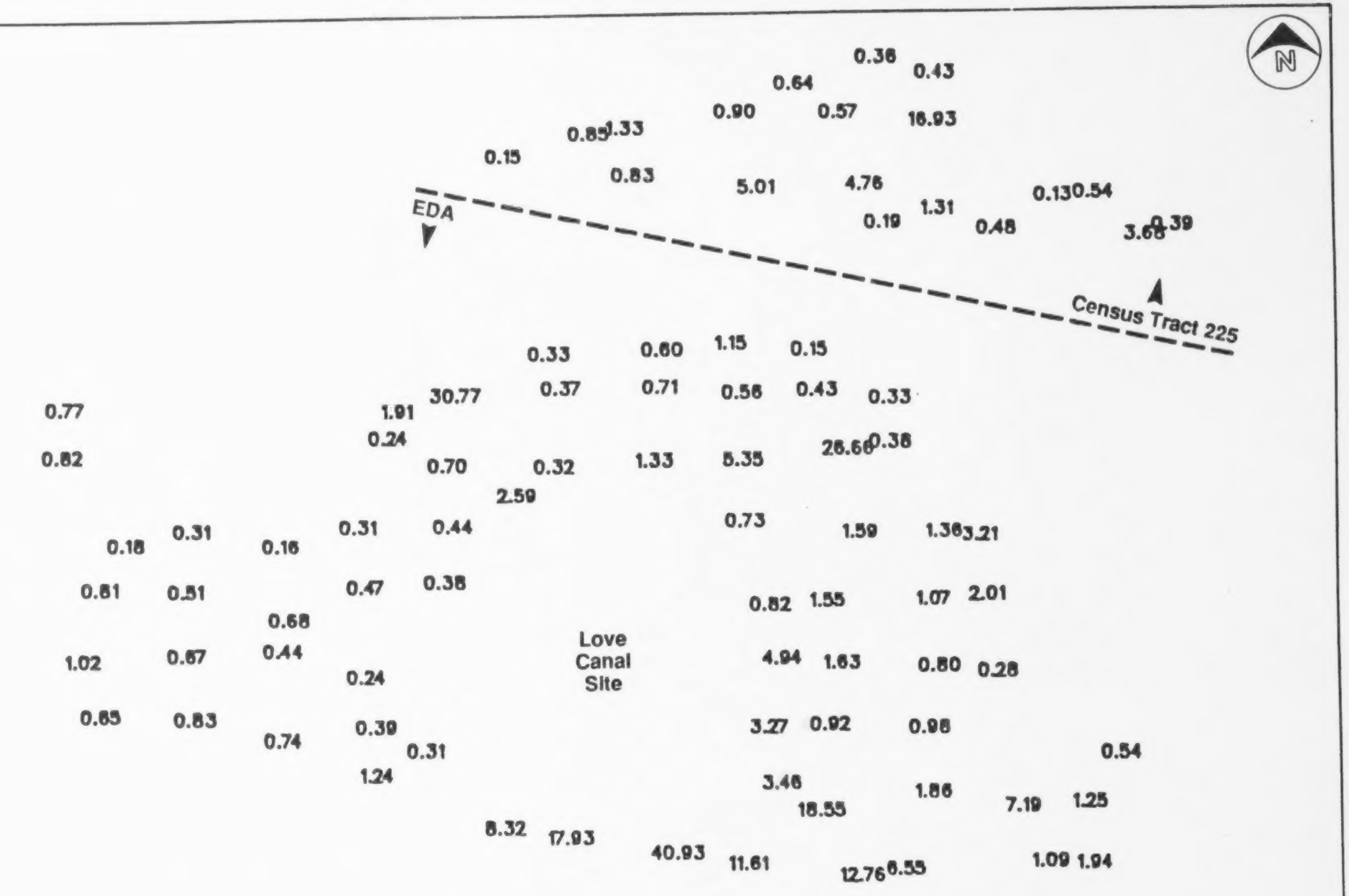
NOTE:
Concentrations shown represent an average of 4 or 5 locations.

Figure L-4 SOIL ASSESSMENT -- INDICATOR CHEMICALS
MAP OF 1,2,-DICHLOROBENZENE CONCENTRATIONS


N
0.49
0.86
0.40
0.95
0.49
9.04
0.23
1.04
1.44
1.13
1.65
1.63
0.80
0.16
0.56
0.25
0.41
9.49
0.92
EDA
Census Tract 225
0.31
1.01
0.89
0.22
0.52
1.53
7.85
0.59
0.81
0.68
0.47
0.44
0.31
0.83
0.96
0.41
1.25
2.62
2.55
0.34
1.83
0.33
0.39
0.22
0.36
0.47
0.64
1.92
1.06
3.54
0.90
0.59
0.52
0.46
0.75
1.47
1.05
1.94
0.53
Love
Canal
Site
1.24
0.71
0.51
0.32
2.41
1.23
0.70
0.29
0.68
0.93
1.08
0.48
0.29
2.17
0.73
0.80
0.52
0.96
2.63
12.11
1.35
24.63
1.00
5.65
10.56
26.84
7.51
7.78
6.11
0.95
1.25

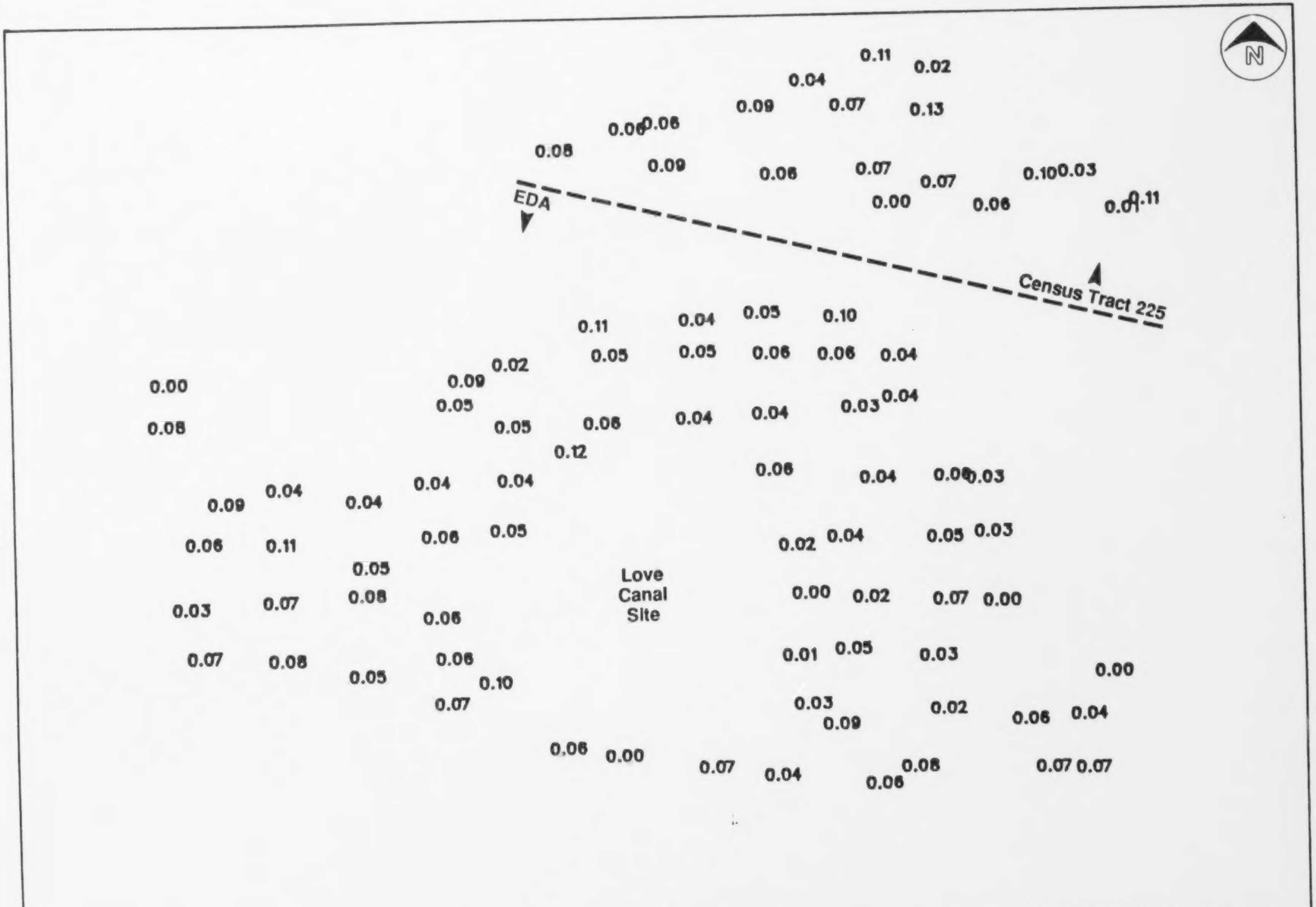
NOTE:
Concentrations shown represent an average of 4 or 5 locations.

Figure L-5 SOIL ASSESSMENT -- INDICATOR CHEMICALS
MAP OF 1,2,4-TRICHLOROBENZENE CONCENTRATIONS


N
0.36
0.43
0.64
0.90
0.57
16.93
0.15
0.85
1.33
0.83
5.01
4.76
0.19
1.31
0.48
0.13
0.54
3.68
0.39
EDA
Census Tract 225
0.33
0.60
1.15
0.15
0.77
1.91
30.77
0.37
0.71
0.56
0.43
0.33
0.24
0.82
0.70
0.32
1.33
5.35
26.66
0.36
2.59
0.18
0.31
0.16
0.31
0.44
0.73
1.59
1.36
3.21
0.81
0.51
0.47
0.38
0.82
1.55
1.07
2.01
0.68
1.02
0.67
0.44
0.24
Love
Canal
Site
4.94
1.63
0.80
0.28
0.65
0.83
0.74
0.39
0.31
3.27
0.92
0.98
0.54
1.24
3.46
18.55
1.86
7.19
1.25
8.32
17.93
40.93
11.61
12.76
6.55
1.09
1.94

NOTE:
Concentrations shown represent an average of 4 or 5 locations.

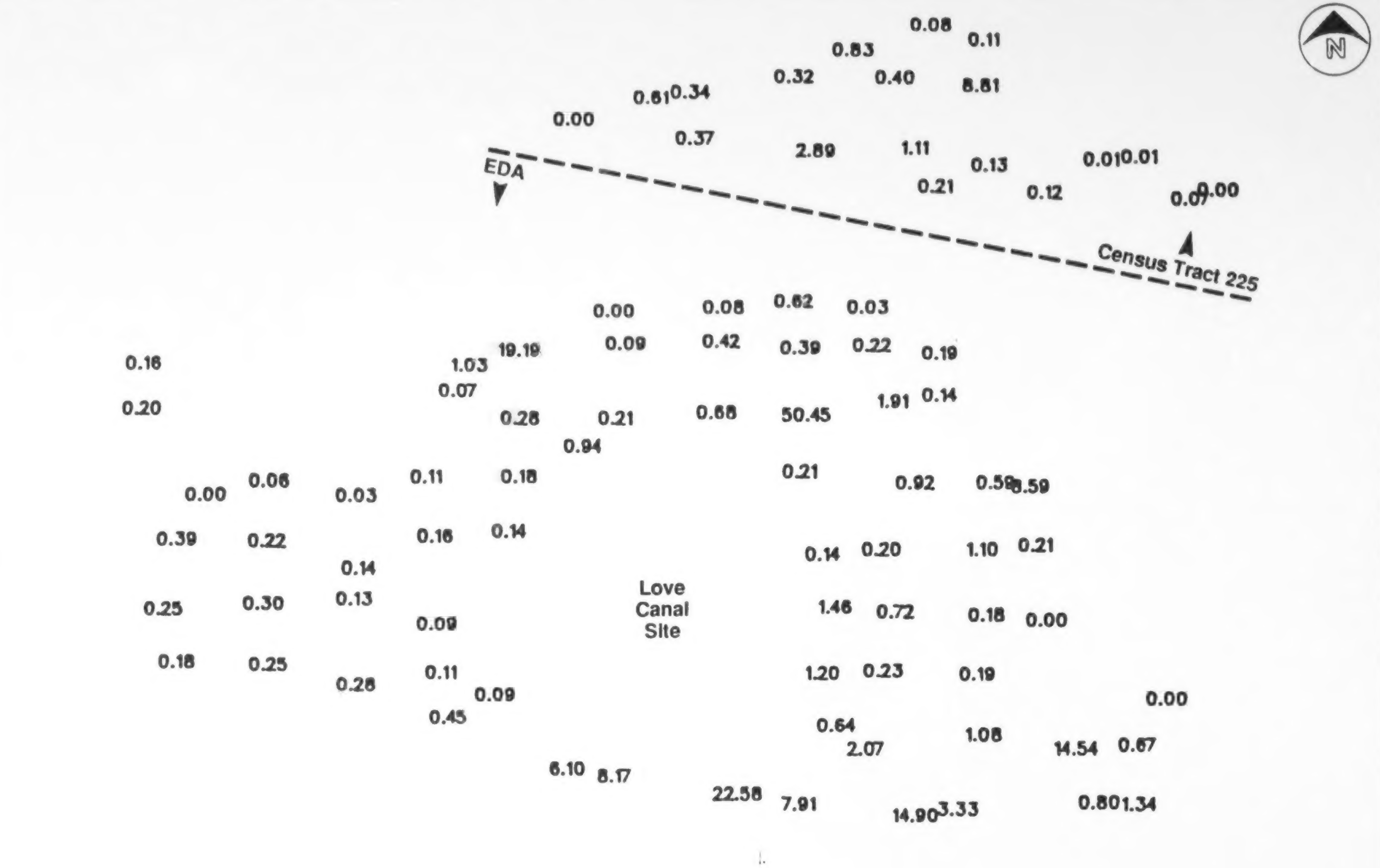
Figure L-6 SOIL ASSESSMENT -- INDICATOR CHEMICALS MAP OF 1,2,3,4-TETRACHLOROBENZENE CONCENTRATIONS



N
0.11
0.02
0.04
0.09
0.07
0.13
0.06
0.06
0.08
0.09
0.06
0.07
0.07
0.10
0.03
EDA
0.00
0.06
0.0
0.11
Census Tract 225
0.11
0.04
0.05
0.10
0.02
0.05
0.05
0.06
0.06
0.04
0.00
0.09
0.05
0.03
0.04
0.08
0.05
0.06
0.04
0.04
0.12
0.09
0.04
0.04
0.04
0.04
0.06
0.04
0.06
0.03
0.06
0.11
0.06
0.05
0.02
0.04
0.05
0.03
0.05
Love
Canal
Site
0.03
0.07
0.08
0.06
0.00
0.02
0.07
0.00
0.07
0.08
0.05
0.06
0.10
0.01
0.05
0.03
0.00
0.07
0.03
0.09
0.02
0.06
0.04
0.06
0.00
0.07
0.04
0.06
0.08
0.07
0.07

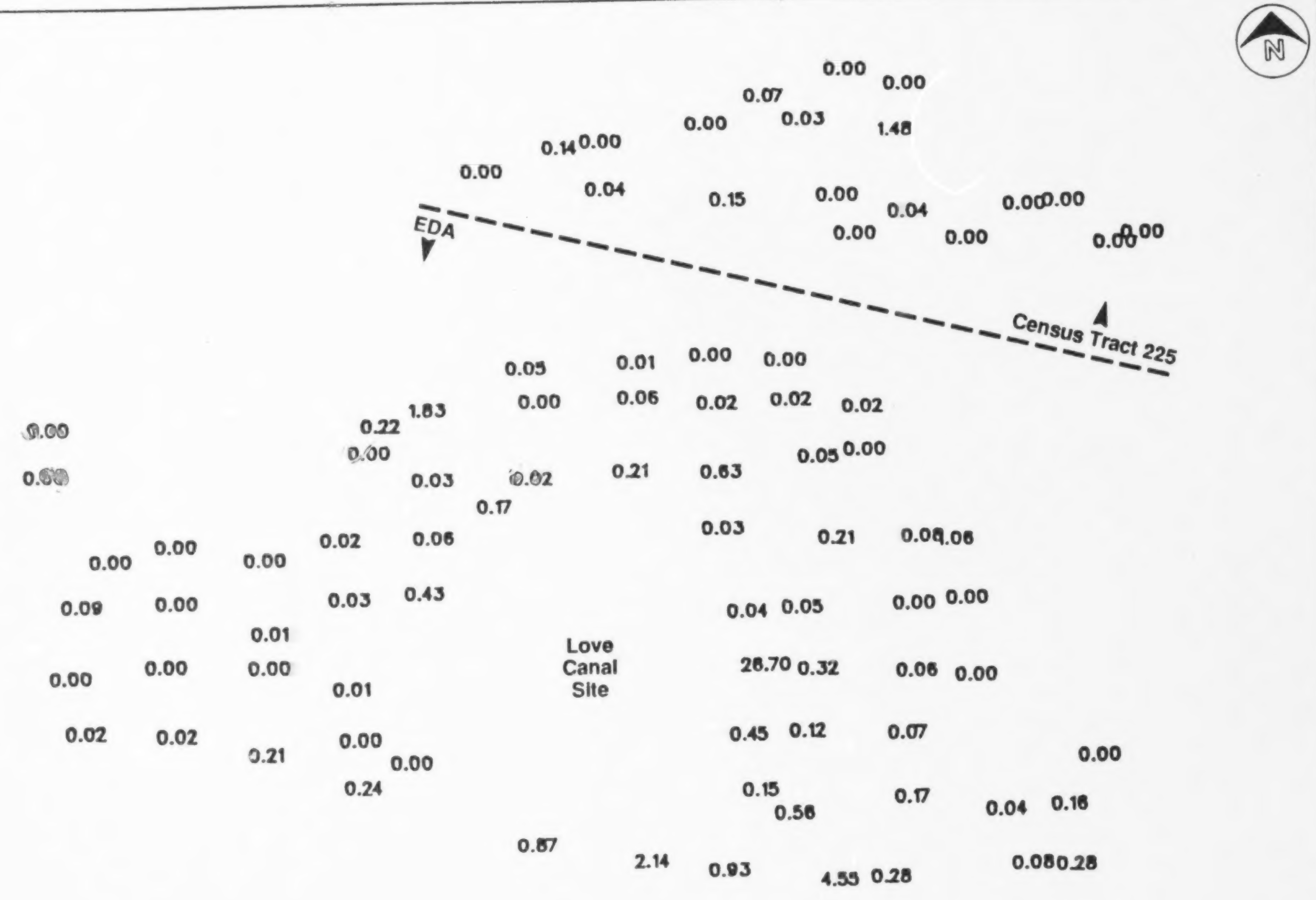
NOTE:
Concentrations shown represent an average of 4 or 5 locations.

Figure L-7 SOIL ASSESSMENT -- INDICATOR CHEMICALS
MAP OF 2-CHLORONAPHTHALENE CONCENTRATIONS


N
0.08
0.11
0.83
0.32
0.40
8.81
0.00
0.61
0.34
0.37
2.89
1.11
0.13
0.01
0.01
0.21
0.12
0.07
0.00
EDA
Census Tract 225
0.00
0.08
0.62
0.03
0.16
1.03
19.19
0.09
0.42
0.39
0.22
0.19
0.07
0.20
0.28
0.21
0.68
50.45
1.91
0.14
0.94
0.00
0.06
0.03
0.11
0.18
0.21
0.92
0.59
0.59
0.39
0.22
0.16
0.14
0.14
0.20
1.10
0.21
0.14
Love Canal Site
0.25
0.30
0.13
0.09
1.46
0.72
0.18
0.00
0.18
0.25
0.28
0.11
0.09
1.20
0.23
0.19
0.45
0.00
0.64
2.07
1.08
14.54
0.67
6.10
8.17
22.58
7.91
14.90
3.33
0.80
1.34

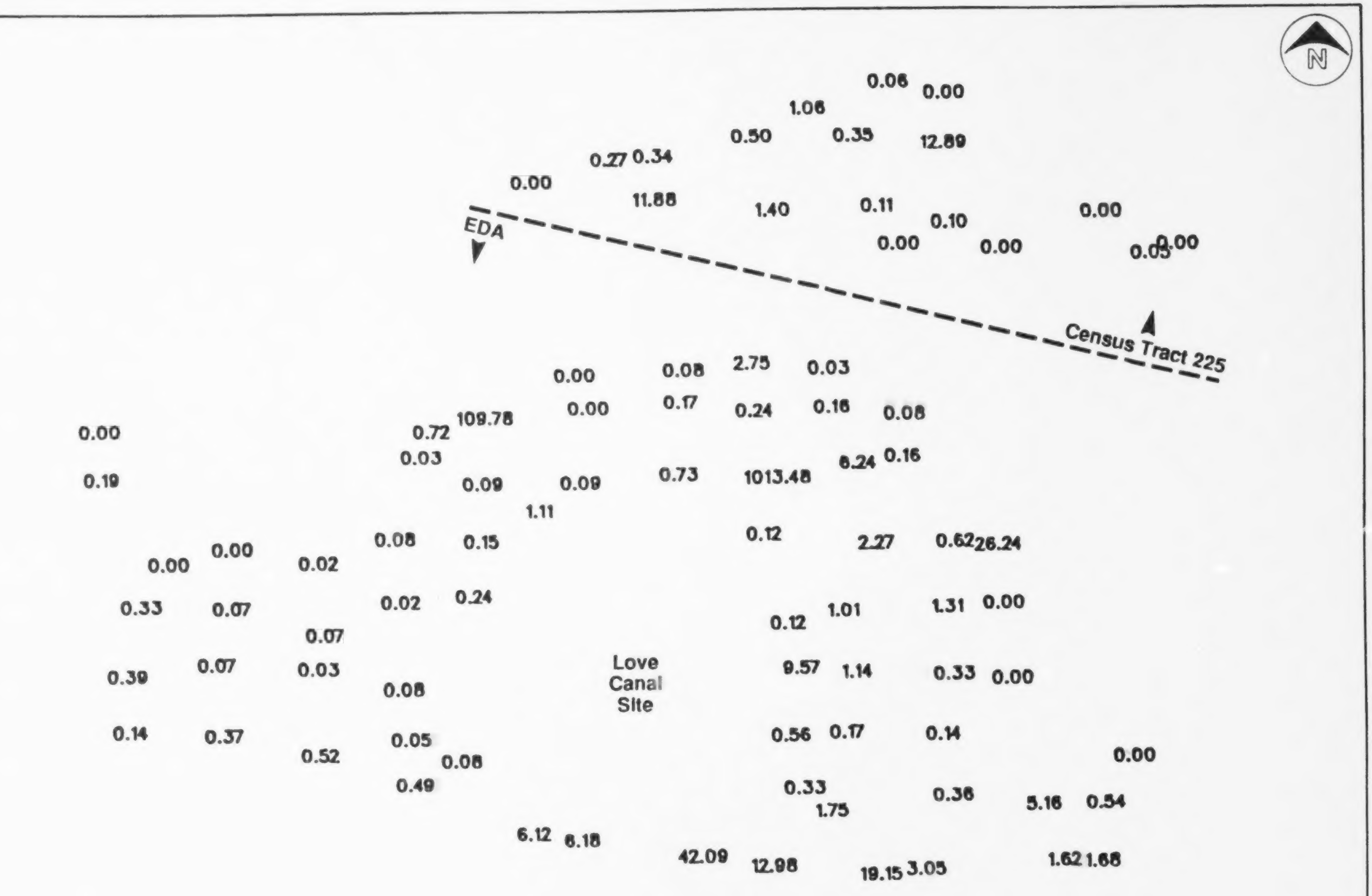
NOTE:
Concentrations shown represent an average of 4 or 5 locations.

Figure L-8 SOIL ASSESSMENT -- INDICATOR CHEMICALS MAP OF ALPHA-BHC CONCENTRATIONS


N
0.00
0.00
0.07
0.03
0.00
1.48
0.14
0.00
0.00
0.04
0.15
0.00
0.00
0.04
0.00
0.00
0.00
0.00
0.00
EDA
Census Tract 225
0.05
0.01
0.00
0.00
0.00
0.06
0.02
0.02
0.02
1.83
0.22
0.00
0.05
0.00
0.00
0.0.[illegible]
0.03
0.02
0.21
0.63
0.17
0.03
0.21
0.08
0.06
0.00
0.00
0.00
0.02
0.06
0.09
0.00
0.03
0.43
0.04
0.05
0.00
0.00
0.01
Love
Canal
Site
0.00
0.00
0.00
0.01
26.70
0.32
0.06
0.00
0.02
0.02
0.21
0.00
0.00
0.45
0.12
0.07
0.00
0.24
0.15
0.56
0.17
0.04
0.16
0.87
2.14
0.93
4.55
0.28
0.08
0.28

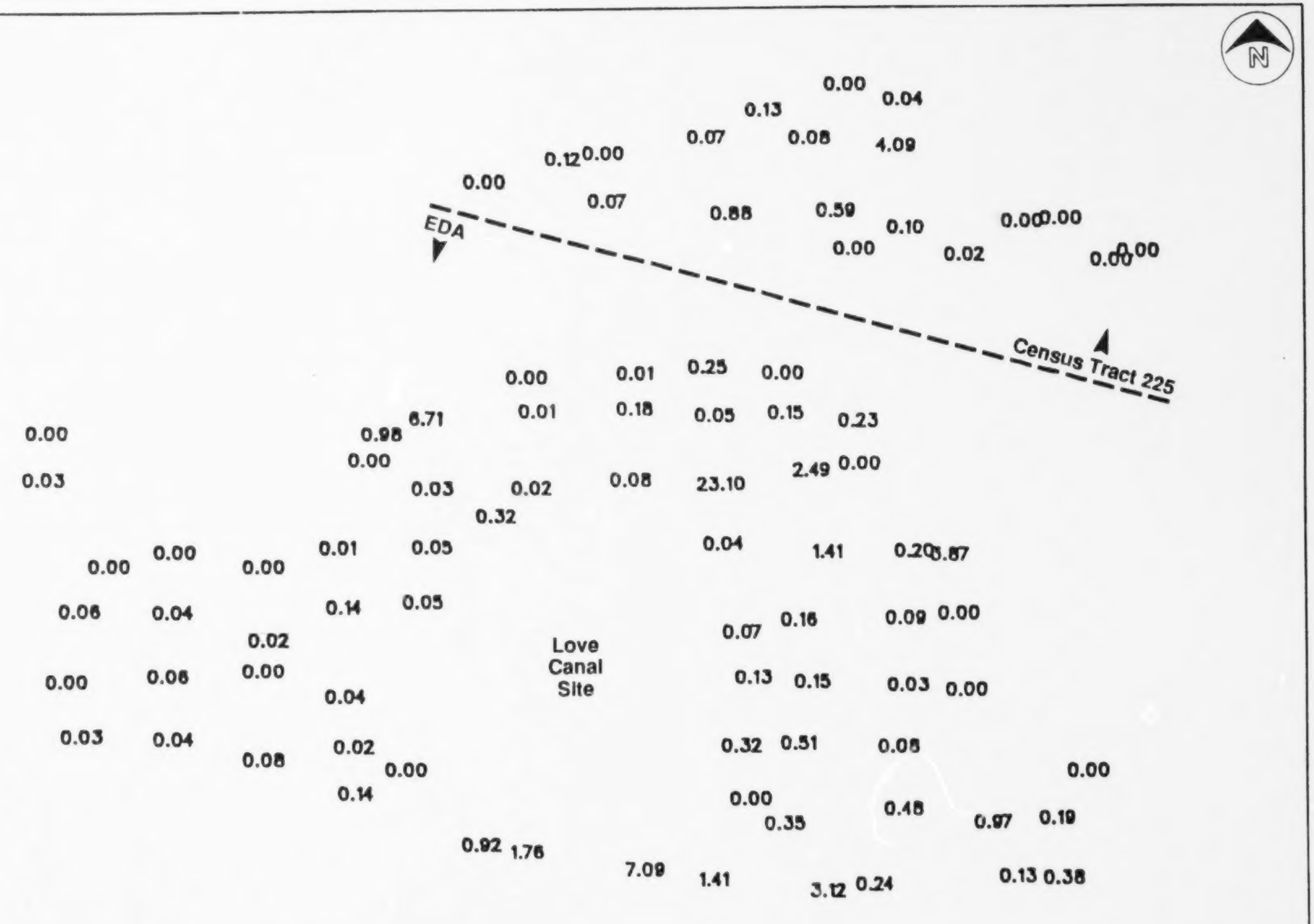
NOTE:
Concentrations shown represent an average of 4 or 5 locations.

Figure L-9 SOIL ASSESSMENT -- INDICATOR CHEMICALS MAP OF DELTA-BHC CONCENTRATIONS


N
0.06
0.00
1.06
0.50
0.35
12.89
0.27
0.34
0.00
11.88
1.40
0.11
0.10
0.00
EDA
0.00
0.00
0.00
0.05
0.00
Census Tract 225
0.00
0.08
2.75
0.03
0.00
0.17
0.24
0.16
0.08
0.00
0.72
109.78
0.03
6.24
0.16
0.19
0.09
0.09
0.73
1013.48
1.11
0.08
0.15
0.12
2.27
0.62
26.24
0.00
0.00
0.02
0.33
0.07
0.02
0.24
0.12
1.01
1.31
0.00
0.07
Love
Canal
Site
0.39
0.07
0.03
0.08
9.57
1.14
0.33
0.00
0.14
0.37
0.52
0.05
0.08
0.56
0.17
0.14
0.00
0.49
0.33
1.75
0.36
5.16
0.54
6.12
6.18
42.09
12.98
19.15
3.05
1.62
1.68

NOTE:
Concentrations shown represent an average of 4 or 5 locations.

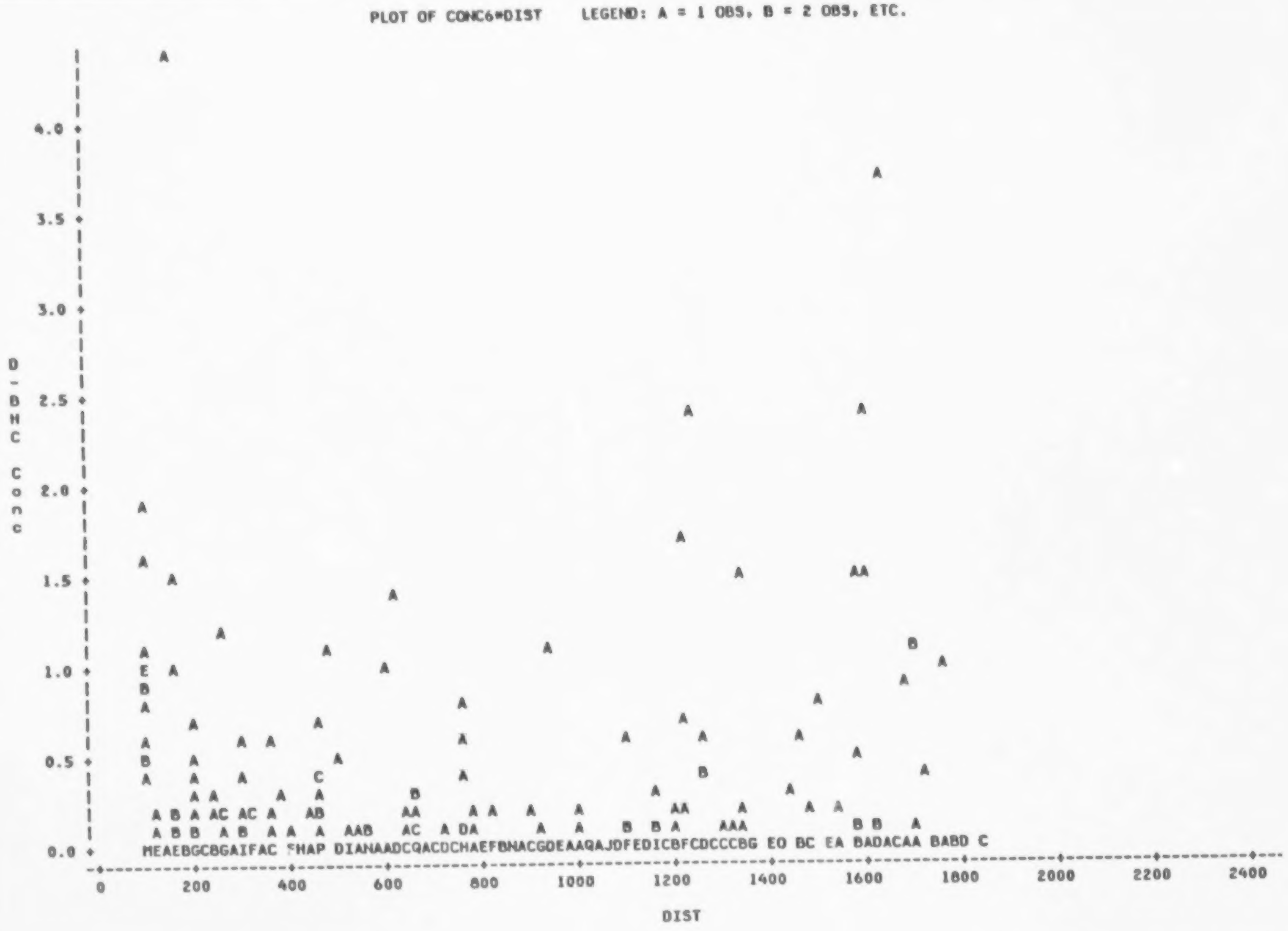
Figure L-10 SOIL ASSESSMENT -- INDICATOR CHEMICALS MAP OF BETA-BHC CONCENTRATIONS



N
0.00
0.04
0.13
0.07
0.08
4.09
0.12
0.00
0.00
0.07
0.88
0.59
0.10
0.00
0.00
0.00
0.02
0.00
0.00
EDA
Census Tract 225
0.00
0.01
0.25
0.00
0.00
0.98
6.71
0.01
0.18
0.05
0.15
0.23
0.00
0.00
2.49
0.00
0.03
0.03
0.02
0.08
23.10
0.32
0.00
0.00
0.00
0.01
0.05
0.04
1.41
0.20
0.87
0.06
0.04
0.14
0.05
0.07
0.16
0.09
0.00
0.02
Love
Canal
Site
0.00
0.06
0.00
0.04
0.13
0.15
0.03
0.00
0.03
0.04
0.08
0.02
0.00
0.14
0.32
0.51
0.05
0.00
0.00
0.35
0.48
0.97
0.19
0.92
1.76
7.09
1.41
3.12
0.24
0.13
0.38

NOTE:
Concentrations shown represent an average of 4 or 5 locations.

Figure L-11 SOIL ASSESSMENT -- INDICATOR CHEMICALS MAP OF GAMMA-BHC CONCENTRATIONS



NOTES:
- A = 1 observation, B = 2 observations, etc.
- For 51 of the samples, one of the two chemicals plotted had no valid results, and the results for those samples are not shown.

Figure L-12 SOIL ASSESSMENT -- INDICATOR CHEMICALS
LOG CONCENTRATION OF DELTA-BHC
VS. DISTANCE FROM LOVE CANAL BOUNDARY

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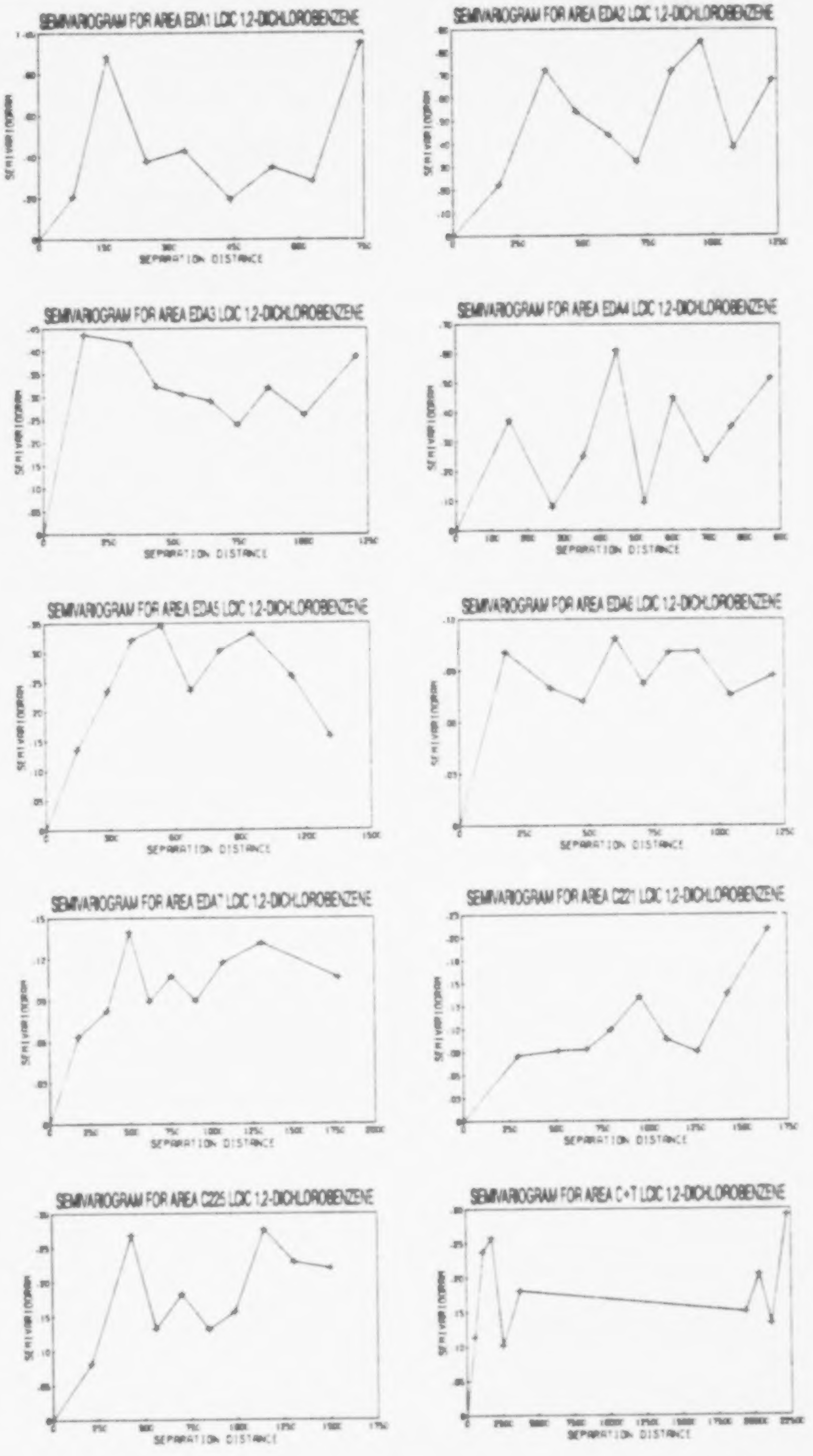
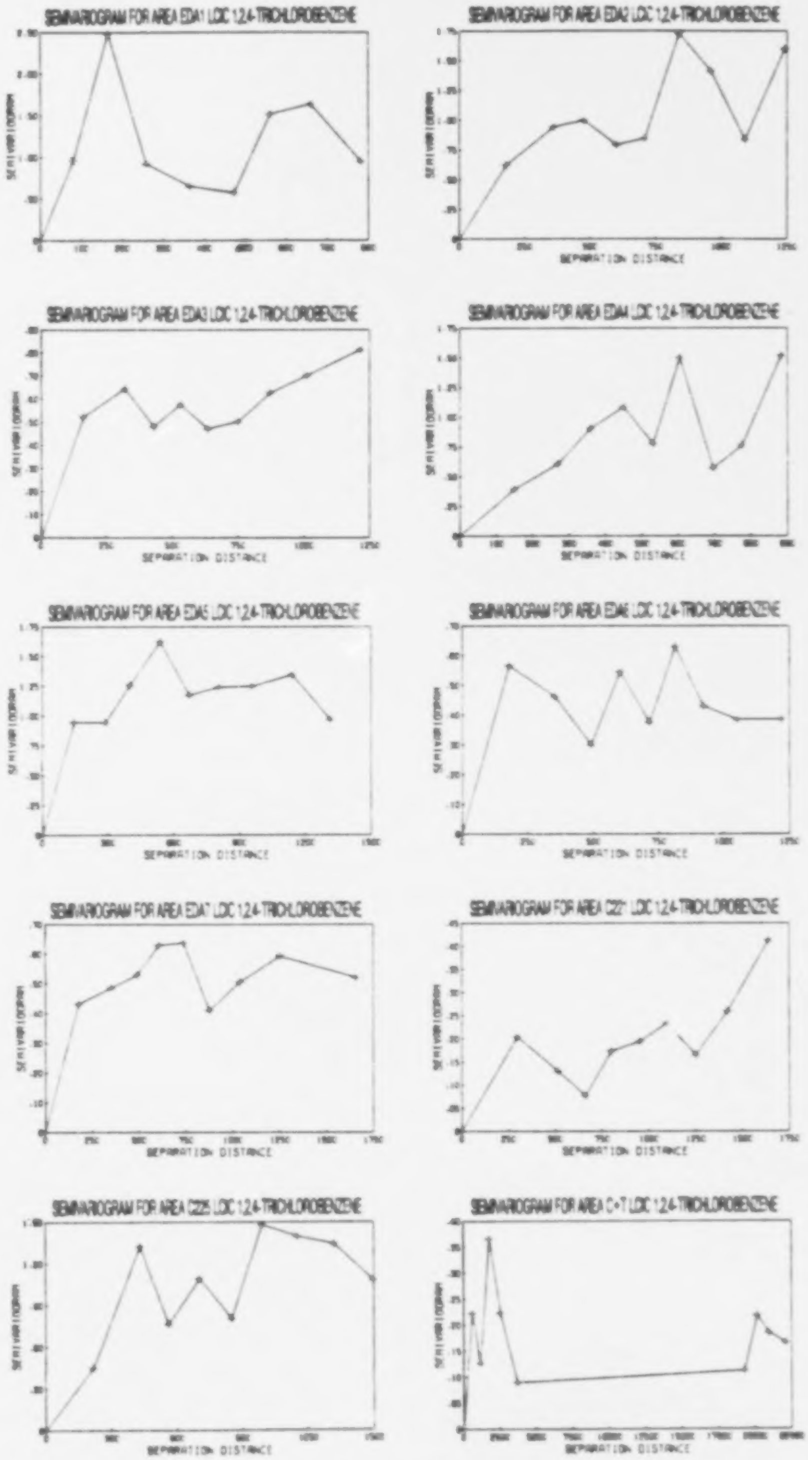
best available copy.



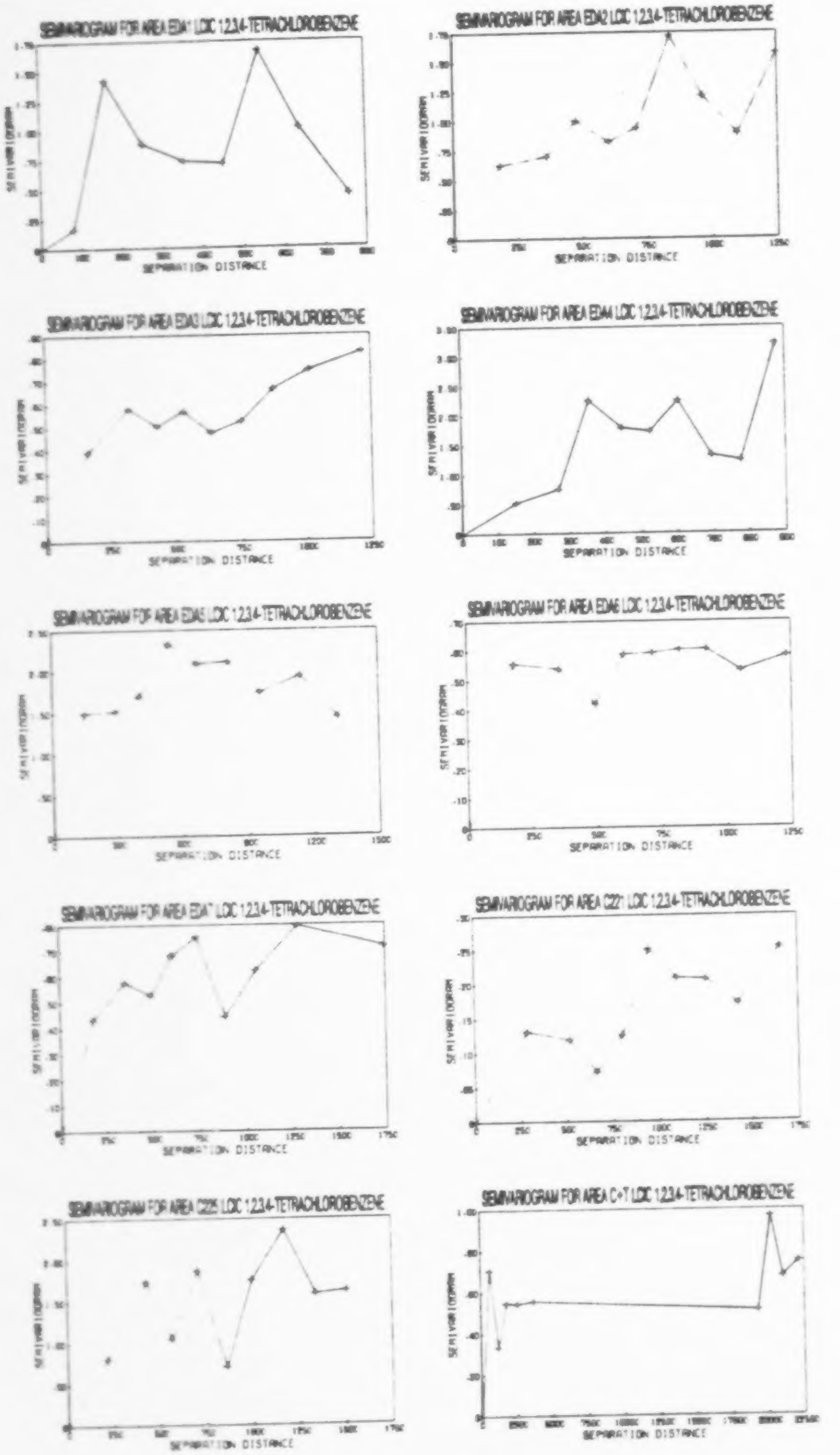
Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-13 SAMPLE VARIOGRAMS FOR LOGARITHMS OF 1,2-DICHLOROBENZENE



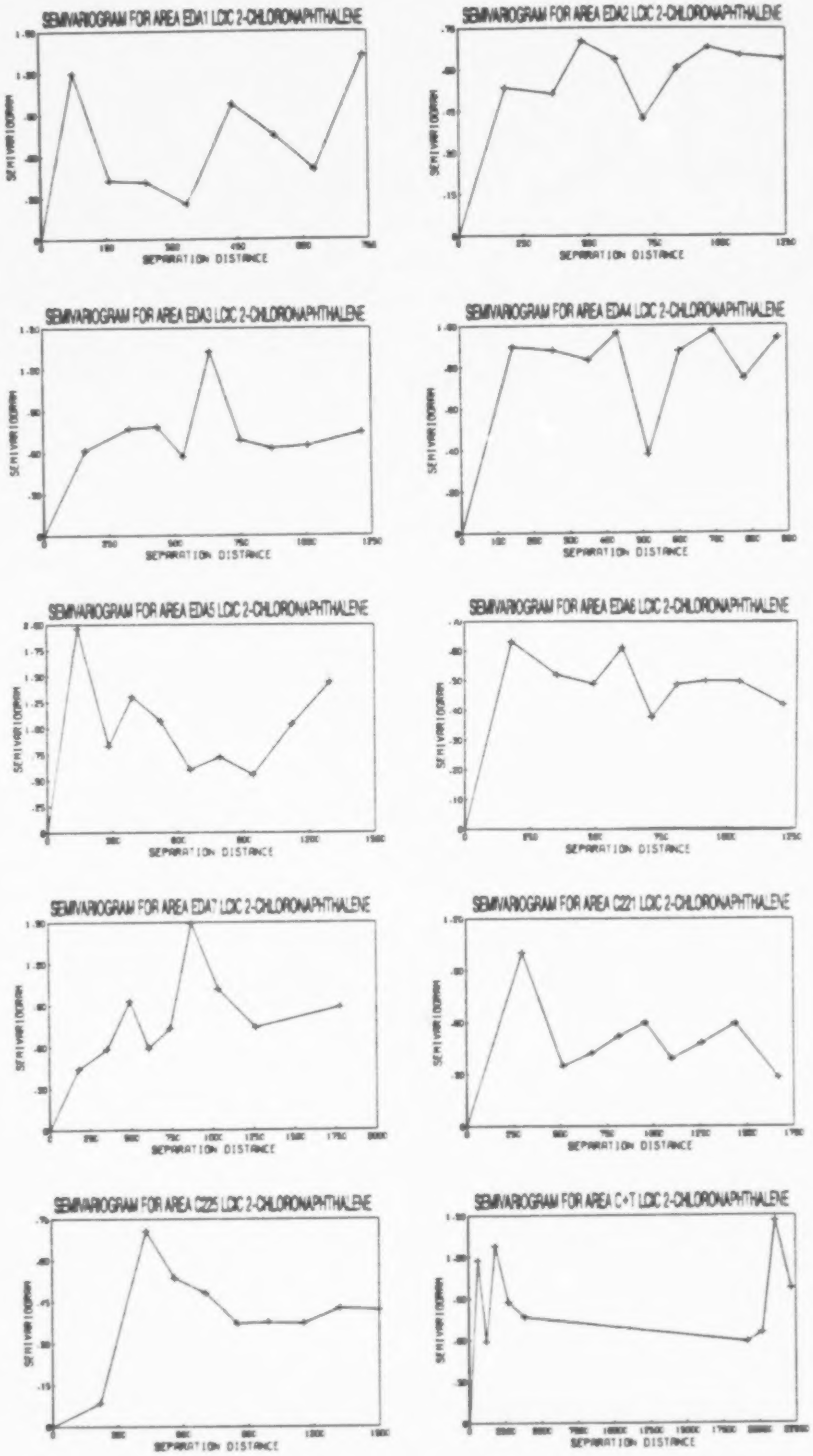
Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-14 SAMPLE VARIOGRAMS FOR LOGARITHMS OF 1,2,4-TRICHLOROBENZENE



Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-15 SAMPLE VARIOGRAMS FOR LOGARITHMS OF 1,2,3,4-TETRACHLOROBENZENE



SEMIVARIOGRAM FOR AREA EDA1 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA EDA2 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA EDA3 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA EDA4 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA EDA5 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA EDA6 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA EDA7 LCIC 2-CHLORONAPHTHALENE

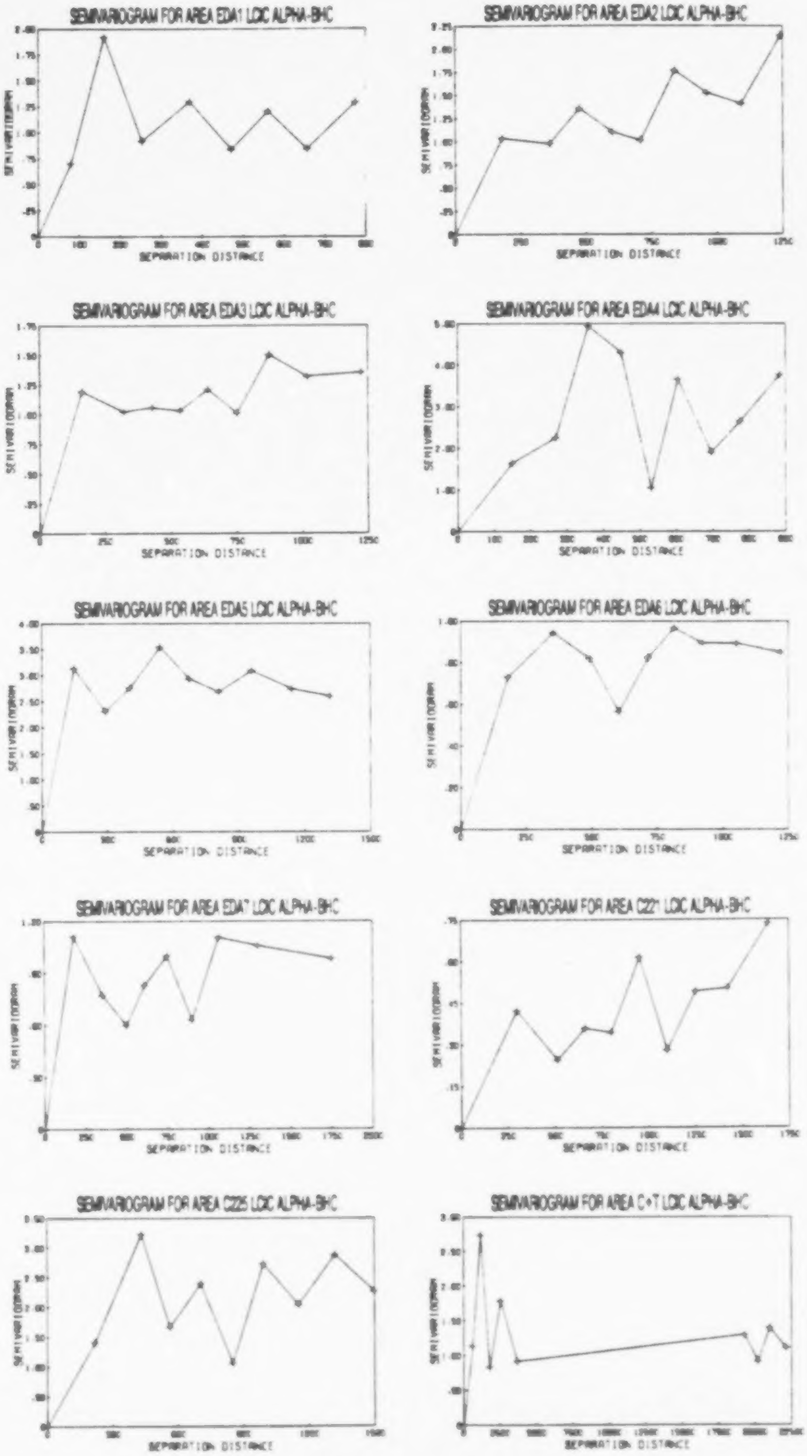
SEMIVARIOGRAM FOR AREA C221 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA C225 LCIC 2-CHLORONAPHTHALENE

SEMIVARIOGRAM FOR AREA C+T LCIC 2-CHLORONAPHTHALENE

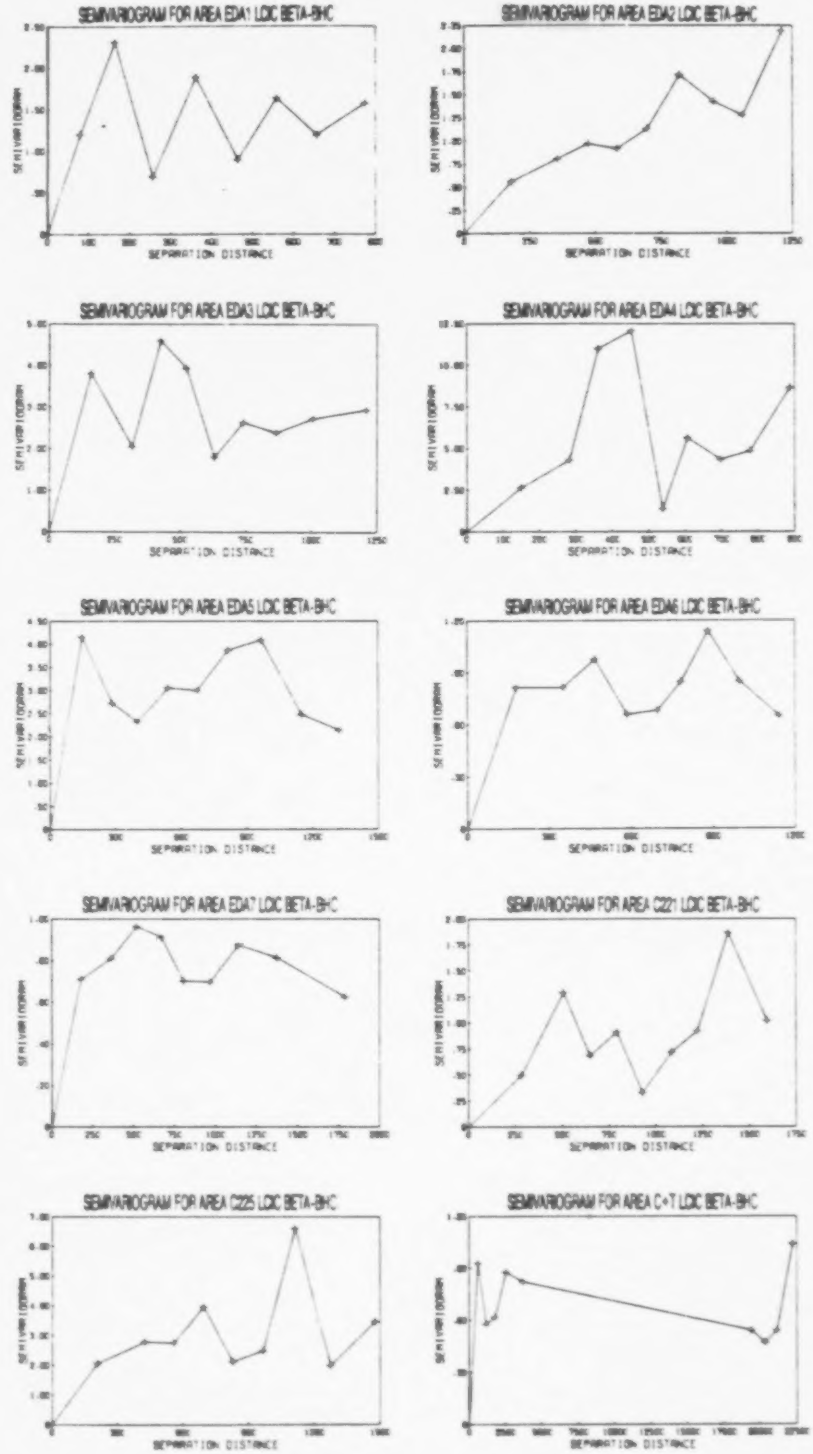
Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-16 SAMPLE VARIOGRAMS FOR LOGARITHMS OF 2-CHLORONAPTHALENE



Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-17 SAMPLE VARIOGRAMS FOR LOGARITHMS OF ALPHA-BHC



SEMIVARIOGRAM FOR AREA EDA1 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA EDA2 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA EDA3 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA EDA4 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA EDA5 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA EDA6 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA EDA7 LOC BETA-BHC

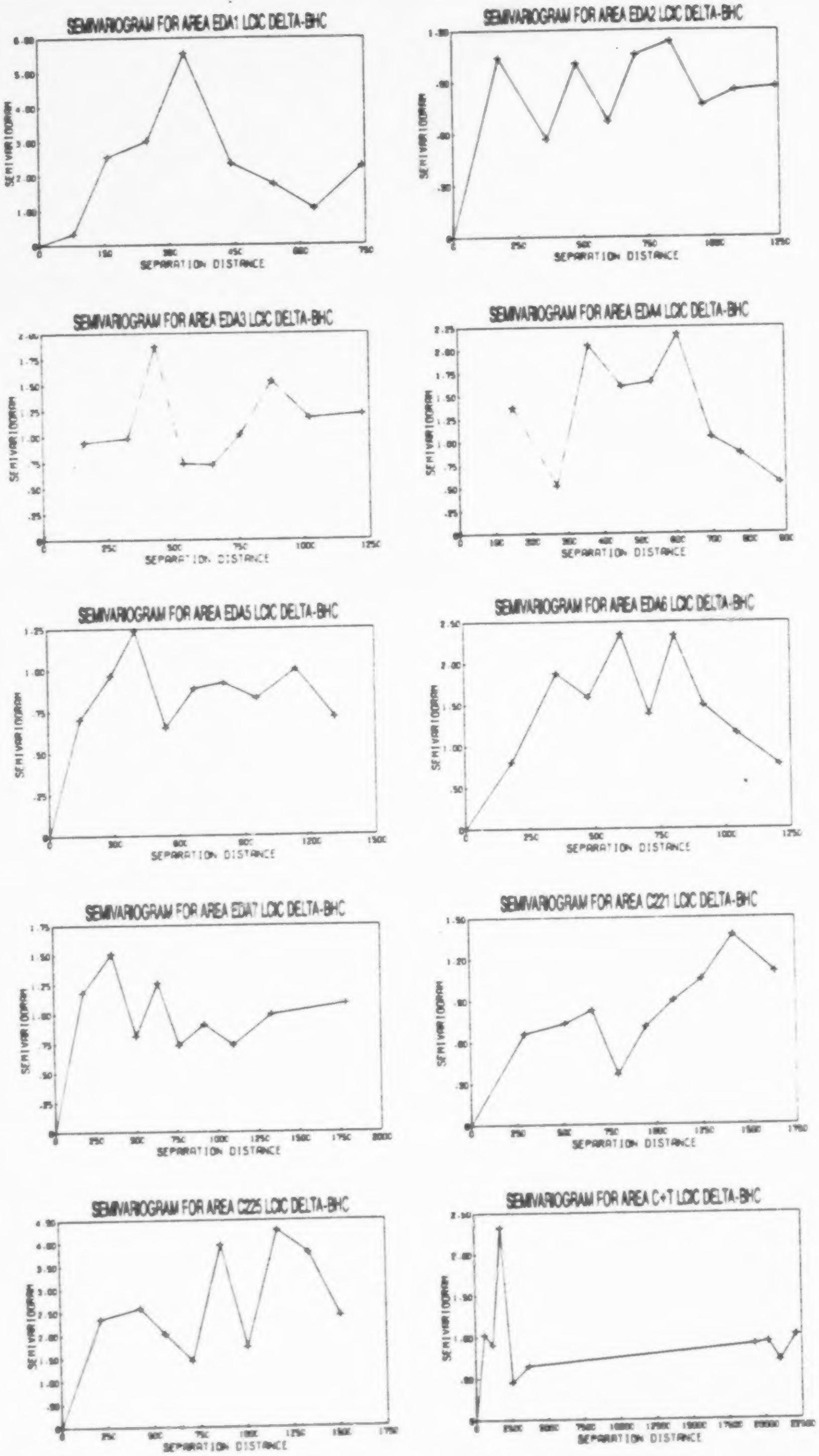
SEMIVARIOGRAM FOR AREA C221 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA C225 LOC BETA-BHC

SEMIVARIOGRAM FOR AREA C+T LOC BETA-BHC

Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-18 SAMPLE VARIOGRAMS FOR LOGARITHMS OF DELTA-BHC


SEMIVARIOGRAM FOR AREA EDA1 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA EDA2 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA EDA3 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA EDA4 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA EDA5 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA EDA6 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA EDA7 LCIC DELTA-BHC

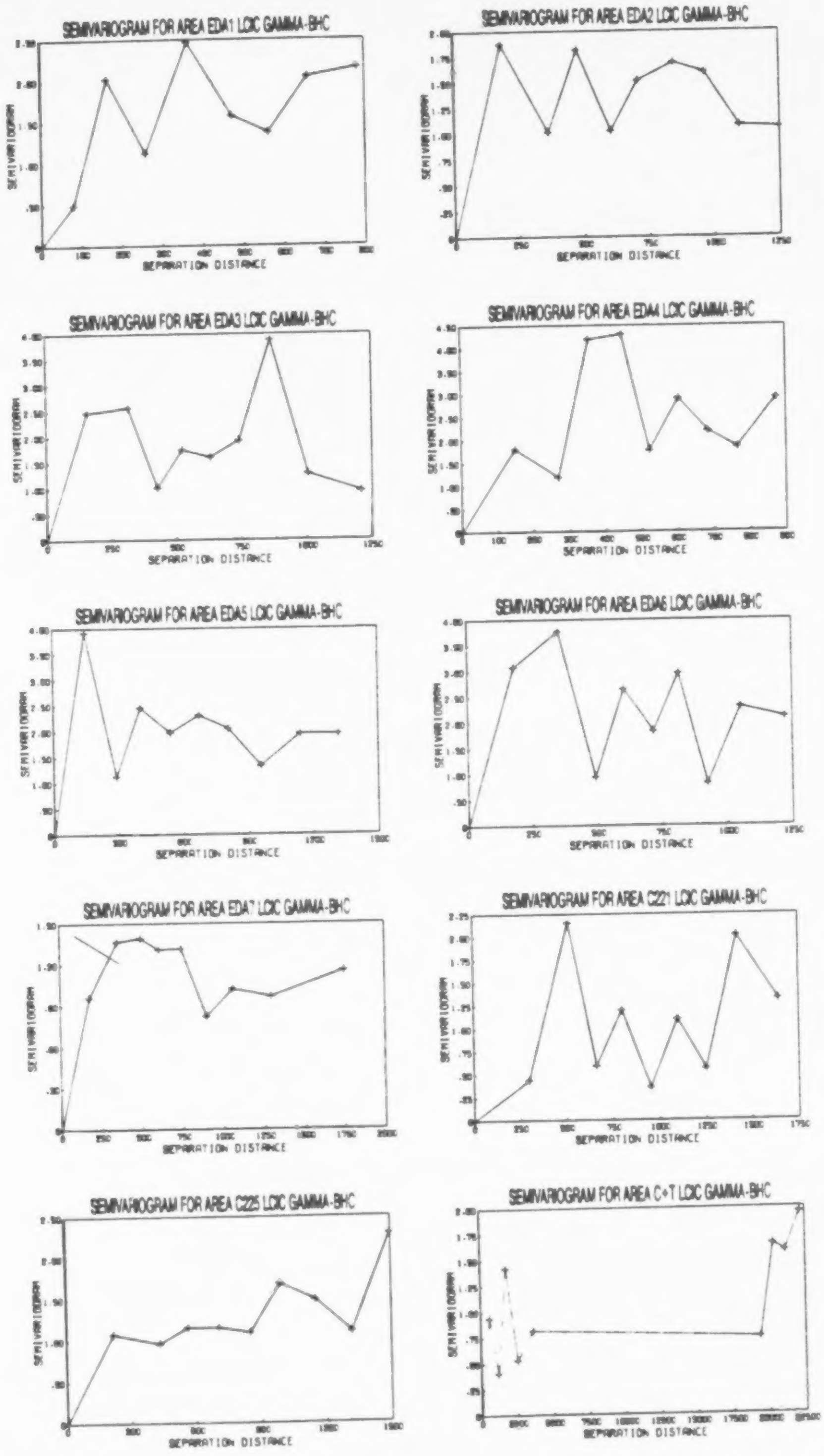
SEMIVARIOGRAM FOR AREA C221 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA C225 LCIC DELTA-BHC

SEMIVARIOGRAM FOR AREA C+T LCIC DELTA-BHC

Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-19 SAMPLE VARIOGRAMS FOR LOGARITHMS OF BETA-BHC



Notes: Separation distances are in feet; nondetectable values were assigned a uniform random number between 0 and an assumed effective detection limit of 0.5 ppb.

Figure L-20 SAMPLE VARIOGRAMS FOR LOGARITHMS OF GAMMA-BHC

APPENDIX M
Neighborhood Comparisons and Redefined EDA Sampling Area Comparisons

Soil Assessment--Indicator Chemicals

Appendix M
NEIGHBORHOOD COMPARISONS AND REDEFINED EDA SAMPLING AREA COMPARISONS
SOIL ASSESSMENT--INDICATOR CHEMICALS

At the request of the TRC and in response to a request by Dr. Schoenfeld (peer review meeting June 22, 1988) additional comparisons were performed. The proposed habitability criteria specified that comparisons were to be done between EDA sampling areas and each of the three comparison areas. The additional comparisons were requested to provide a context in which the non-statistical significance of the statistical comparisons could be judged.

The comparisons requested are presented in a format identical with that of the comparisons presented in Volume III. The following analyses are presented:

- EDA neighborhoods and comparison areas compared with other EDA neighborhoods and comparison areas for each LCIC (univariate test), based only on the observations classified as Good (Table M-1a and b and Figure M-1).

- EDA neighborhoods and comparison areas compared with other EDA neighborhoods and comparison areas for all LCICs considered together (multivariate test), based only on the observations classified as Good (Table M-2a and b and Figure M-2).

- Redefined EDA Sampling Areas 2' ("two prime") and 3' compared with all other EDA sampling areas and comparison areas for each LCIC (univariate test), based only on the observations classified as Good (Table M-3a through c and Figure M-3).

- Redefined EDA Sampling Areas 2' and 3' compared with all other EDA sampling areas for all LCICs considered together (multivariate test), based only on the observations classified as Good (Table M-4a and b).

- EDA sampling areas and one aggregate comparison area (all three comparison areas combined) compared to other EDA sampling areas and the one aggregate comparison area for each LCIC (univariate test), based only on the observations classified as Good (Table M-5a and b).

- EDA sampling areas and one aggregate comparison area (all three comparison areas combined) compared to other EDA sampling areas for all LCICs considered together (multivariate test), based only on the observations classified as Good (Table M-6a and b).

- One aggregate EDA sampling area (all seven EDA sampling areas combined) compared to the three comparison areas for each LCIC (univariate test), based only on the observations classified as Good (Table M-7a and b).
- One aggregate EDA sampling area (all seven EDA sampling areas combined) compared to the three comparison areas for all LCICs considered together (multivariate test), based only on the observations classified as Good (Table M-8a and b).

DISCUSSION

NEIGHBORHOOD/COMPARISON AREA COMPARISONS

Tables M-1 (a and b) and M-2 (a and b) and Figures M-1 and M-2 present the results of comparing the EDA neighborhood/comparison areas. Although the statistical comparisons reported in Volume III were performed based on the EDA sampling areas (following the recommendation of the peer review), during design of the field study, the randomization of sampling sites (along with other effects considered important) was performed at the neighborhood level in the EDA. It is therefore statistically valid to compare EDA neighborhoods with the other EDA neighborhoods and the comparison areas. There are, however, two drawbacks in performing the comparisons at the neighborhood level:

1. The number of comparisons increases from 45 (45 unique pairs among the 7 EDA sampling areas and 3 comparison areas) per LCIC to 120 per LCIC for the univariate test and from 45 to 120 for the multivariate test. This yields an increase in total comparisons from 405 to 1,080 and aggravates the multiple comparisons problem (discussed in Appendix A of Volume III).
2. Because the number of observations per neighborhood is less than or equal to the number of observations per sampling area, the power to detect a difference of a specific size (e.g., order of magnitude) is smaller at the neighborhood level than at the sampling-area level.

REAGGREGATION OF SAMPLING AREAS 2 AND 3

As a background to the second sensitivity analysis described herein, the original aggregation of EDA neighborhoods defined EDA Sampling Area 2 as a combination of the two more southerly neighborhoods (2 and 3). The original EDA Sampling Area 3 was defined as a combination of the two more northerly neighborhoods (4 and 5). (See Figure M-1.) Following the request of the TRC, new tables and a figure are presented in this appendix showing the results of comparisons were conducted using recombined EDA Neighborhoods 2, 3, 4, and 5. The purpose of these comparisons is to explore the effect of the proximity of the Canal on the results of these particular EDA sampling area comparisons. The new aggregation couples the two more westerly neighborhoods closest to the Canal (Neighborhoods 2 and 4) into one sampling area, denoted EDA Sampling Area 2', and the two more easterly neighborhoods farther away from the Canal (Neighborhoods 3 and 5) into another sampling area, denoted 3'.

Tables M-3 (a through c) and M-4 (a and b) and Figure M-3 show the results of comparing different aggregations of EDA Neighborhoods 2 through 5 with the other EDA sampling areas and comparison areas.

COMPARISON AREAS COMBINED AND ALL EDA SAMPLING AREAS COMBINED

Tables M-5 (a and b) and M-6 (a and b) present the results of comparing the original seven EDA sampling areas with one aggregate comparison area (all three comparison areas combined). Tables M-7 (a and b) and M-8 (a and b) presented the results of comparing one aggregate EDA sampling area (all the original seven EDA sampling areas combined) with the three separate comparison areas. The purpose of generating Tables M-5 (a and b) through M-8 (a and b) is to explore the pattern of differences between the EDA region and the comparison areas on a grosser scale than that of the original neighborhoods or sampling areas.

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Table M-1a
RESULTS FOR NONPARAMETRIC UNIVARIATE NEIGHBORHOOD/COMPARISON AREA TO NEIGHBORHOOD/COMPARISON AREA COMPARISONS[a,b,c,d,e]

LCIC	Neighborhood/ Comparison Area	Median Conc. (ppb)	EDA Neighborhoods													Comparison Areas		
			1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
			1.01	0.42	0.33	0.42	0.39	0.36	0.41	0.39	0.36	0.42	0.31	0.38	0.37	0.39	0.43	0.36
DCB	1	1.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	0.42	++		o	o	o	--	o	o	--	o	--	o	o	o	o	--
	3	0.33	++	o		o	o	o	o	o	o	o	o	o	o	o	o	o
	4	0.42	++	o	o		o	-	o	o	o	o	o	o	o	o	o	--
	5	0.39	++	o	o	o		-	o	o	o	o	o	o	o	o	o	-
	6	0.36	++	++	o	+	+		++	+	o	++	o	o	+	++	+	o
	7	0.41	++	o	o	o	o	--		o	-	o	-	o	o	o	o	o
	8	0.39	++	o	o	o	o	-	o		o	o	-	-	o	o	o	-
	9	0.36	++	++	o	o	o	o	+	o		o	o	o	o	o	o	o
	10	0.42	++	o	o	o	o	--	o	o	o		--	o	o	o	o	-
	11	0.31	++	++	o	o	o	o	+	+	o	++		o	o	++	o	o
	12	0.38	++	o	o	o	o	o	o	+	o	o	o		o	o	o	o
	13	0.37	++	o	o	o	o	-	o	o	o	o	o	o		o	o	o
	221	0.39	++	o	o	o	o	--	o	o	o	o	--	o	o		o	--
	225	0.36	++	o	o	o	o	-	o	o	o	o	o	o	o	o		o
	C&T	0.43	++	++	o	++	+	o	o	+	o	+	o	o	o	++	o	
			8.67	1.24	0.84	0.91	0.79	0.43	0.85	0.59	0.40	0.59	0.32	0.39	0.56	0.65	0.60	0.13
TCB	1	8.67		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	1.24	++		o	o	o	--	o	-	--	-	--	--	--	--	-	--
	3	0.84	++	o		o	o	--	o	o	--	-	--	--	--	-	-	--
	4	0.91	++	o	o		o	--	o	o	--	-	--	--	-	-	-	--
	5	0.79	++	o	o	o		--	o	o	o	o	--	--	-	o	o	--
	6	0.43	++	++	++	++	++		o	o	o	o	o	o	o	+	o	--
	7	0.85	++	o	o	o	o	o		o	-	o	-	-	o	o	o	--
	8	0.59	++	+	o	o	o	o	o		o	o	--	-	o	o	o	--
	9	0.40	++	++	++	++	o	o	+	o		+	o	o	o	++	o	--
	10	0.59	++	+	+	+	o	o	o	o	-		--	--	o	o	o	--
	11	0.32	++	++	++	++	++	o	+	++	o	++		o	++	++	o	--
	12	0.39	++	++	++	++	++	o	+	+	o	++	o		++	++	++	--
	13	0.56	++	++	++	+	+	o	o	o	o	o	--	--		o	o	--
	221	0.65	++	++	+	+	o	-	o	o	--	o	--	--	o		o	--
	225	0.13	++	+	+	+	o	o	o	o	o	o	o	--	o	o		--
	C&T	0.60	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	

Table M-1a
(continued)

LCIC	Neighborhood/ Comparison Area	Median Conc. (ppb)	EDA Neighborhoods													Comparison Areas		
			1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
			11.48	1.39	1.11	0.99	1.08	0.38	0.82	0.48	0.32	0.64	0.30	0.31	0.53	0.53	0.61	0.05
TeCB	1	11.48		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	1.39	++		o	-	o	--	-	--	--	--	--	--	--	--	--	--
	3	1.11	++	o		o	o	--	-	-	--	-	--	--	--	--	--	--
	4	0.99	++	+	o		o	--	o	o	--	-	--	--	--	--	-	--
	5	1.08	++	o	o	o		--	o	-	--	o	--	--	--	--	o	--
	6	0.38	++	++	++	++	++		+	o	o	o	o	o	o	+	o	--
	7	0.82	++	+	+	o	o	-		o	o	o	-	--	o	o	o	--
	8	0.48	++	++	+	o	+	o	o		o	o	o	o	o	o	o	--
	9	0.32	++	++	++	++	++	o	o	o		+	o	o	o	+	o	--
	10	0.64	++	++	+	+	o	o	o	o	-		--	--	o	o	o	--
	11	0.30	++	++	++	++	++	o	+	o	o	++		o	++	++	+	--
	12	0.31	++	++	++	++	++	o	++	o	o	++	o		++	++	++	--
	13	0.53	++	++	++	++	++	o	o	o	o	o	--	--		o	o	--
	221	0.53	++	++	++	++	++	-	o	o	-	o	--	--	o		o	--
	225	0.05	++	++	++	+	o	o	o	o	o	o	-	--	o	o		--
	C&T	0.61	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	
			ND	0.04	0.04	0.02	0.04	0.04	0.07	0.04	0.07	ND	0.04	0.07	0.06	0.06	0.07	0.03
CNP	1	ND		o	o	o	o	o	o	o	o	o	o	o	+	o	+	o
	2	0.04	o		o	o	o	o	o	o	o	o	o	o	o	o	o	o
	3	0.04	o	o		o	o	o	o	o	o	o	o	o	+	o	+	o
	4	0.02	o	o	o		o	o	o	o	o	o	o	+	++	o	++	o
	5	0.04	o	o	o	o		o	o	o	o	o	o	o	+	o	o	o
	6	0.04	o	o	o	o	o		o	o	o	o	o	o	+	o	o	o
	7	0.07	o	o	o	o	o	o		o	o	o	o	o	o	o	o	o
	8	0.04	o	o	o	o	o	o	o		o	o	o	o	+	o	o	o
	9	0.07	o	o	o	o	o	o	o	o		o	o	o	o	o	o	o
	10	ND	o	o	o	o	o	o	o	o	o		o	o	++	o	+	o
	11	0.04	o	o	o	o	o	o	o	o	o	o		+	+	+	+	o
	12	0.07	o	o	o	-	o	o	o	o	o	o	-		o	o	o	-
	13	0.06	-	o	-	--	-	-	o	-	o	--	-	o		o	o	--
	221	0.06	o	o	o	o	o	o	o	o	o	o	-	o	o		o	o
	225	0.03	-	o	-	--	o	o	o	o	o	-	-	o	o	o		-
	C&T	0.07	o	o	o	o	o	o	o	o	o	o	o	+	++	o	+	

Table M-1a
(continued)

LCIC	Neighborhood/ Comparison Area	Median Conc. (ppb)	EDA Neighborhoods													Comparison Areas		
			1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
			8.25	0.33	0.50	0.20	0.23	0.12	0.04	0.13	0.16	0.15	0.06	0.08	0.14	0.18	0.11	ND
a-BHC	1	8.25		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	0.33	++		o	-	o	-	o	-	--	--	--	--	--	--	-	--
	3	0.50	++	o		-	o	-	-	-	--	--	--	--	--	--	--	--
	4	0.20	++	+	+		o	o	o	o	o	-	--	--	o	o	o	--
	5	0.23	++	o	o	o		o	o	o	o	o	-	o	o	o	o	--
	6	0.12	++	+	+	o	o		o	o	o	o	o	o	o	o	o	--
	7	0.04	++	o	+	o	o	o		o	o	o	o	o	o	o	o	--
	8	0.13	++	+	+	o	o	o	o		o	o	o	o	o	o	o	--
	9	0.16	++	++	++	o	o	o	o	o		o	o	o	o	o	o	--
	10	0.15	++	++	++	+	o	o	o	o	o		o	o	o	o	o	--
	11	0.06	++	++	++	++	+	o	o	o	o	o		o	o	+	o	--
	12	0.08	++	++	++	++	o	o	o	o	o	o	o		o	o	o	--
	13	0.14	++	++	++	o	o	o	o	o	o	o	o	o		o	o	--
	221	0.18	++	++	++	o	o	o	o	o	o	o	-	o	o		o	--
	225	ND	++	+	++	o	o	o	o	o	o	o	o	o	o	o		--
	C&T	0.11	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	
			1.13	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	1	1.13		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	0.10	++		o	o	--	--	--	-	--	--	--	--	--	--	--	--
	3	ND	++	o		o	o	--	o	o	-	--	--	--	--	--	--	--
	4	ND	++	o	o		o	-	o	o	-	--	--	--	-	--	o	--
	5	ND	++	++	o	o		o	o	o	o	-	o	o	o	-	o	--
	6	ND	++	++	++	+	o		o	o	o	o	o	o	o	-	o	--
	7	ND	++	++	o	o	o	o		o	o	-	o	o	o	-	o	--
	8	ND	++	+	o	o	o	o	o		o	-	o	o	o	--	o	--
	9	ND	++	++	+	+	o	o	o	o		o	o	o	o	o	o	--
	10	ND	++	++	++	++	+	o	+	+	o		o	o	o	o	o	o
	11	ND	++	++	++	++	o	o	o	o	o	o		o	o	o	o	--
	12	ND	++	++	++	++	o	o	o	o	o	o	o		o	o	o	-
	13	ND	++	++	++	+	o	o	o	o	o	o	o	o		o	o	--
	221	ND	++	++	++	++	+	+	+	++	o	o	o	o	o		o	o
	225	ND	++	++	++	o	o	o	o	o	o	o	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	o	++	+	++	o	++	

Table M-1a
(continued)

LCIC	Neigh-borhood/ Comparison Area	Median Conc. (ppb)	EDA Neighborhoods													Comparison Areas		
			1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
			11.58	0.16	0.39	0.13	0.08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
b-BHC	1	11.58		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	0.16	++		o	o	o	o	o	o	--	o	-	--	o	--	o	--
	3	0.39	++	o		o	o	o	-	o	--	-	--	--	--	--	-	--
	4	0.13	++	o	o		o	o	o	o	--	o	-	--	o	--	o	--
	5	0.08	++	o	o	o		o	o	o	o	o	-	--	o	-	o	--
	6	ND	++	o	o	o	o		o	o	-	o	o	--	o	-	o	--
	7	ND	++	o	+	o	o	o		o	o	o	o	o	o	o	o	--
	8	ND	++	o	o	o	o	o	o		o	o	o	-	o	o	o	--
	9	ND	++	++	++	++	o	+	o	o		o	o	o	o	o	+	--
	10	ND	++	o	+	o	o	o	o	o	o		o	-	o	o	o	--
	11	ND	++	+	++	+	+	o	o	o	o	o		o	o	o	o	--
	12	ND	++	++	++	++	++	++	o	+	o	+	o		++	o	++	-
	13	ND	++	o	++	o	o	o	o	o	o	o	o	--		o	o	--
	221	ND	++	++	++	++	+	+	o	o	o	o	o	o	o		+	--
	225	ND	++	o	+	o	o	o	o	o	-	o	o	--	o	-		--
	C&T	ND	++	++	++	++	++	++	++	++	++	++	++	+	++	++	++	
			1.73	0.05	0.09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC	1	1.73		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2	0.05	++		o	o	o	o	o	o	--	--	--	--	--	--	-	--
	3	0.09	++	o		o	o	-	-	o	--	--	--	--	--	--	o	--
	4	ND	++	o	o		o	o	o	o	--	--	--	--	-	--	o	--
	5	ND	++	o	o	o		o	o	o	o	-	o	-	o	-	o	--
	6	ND	++	o	+	o	o		o	o	o	-	o	-	o	-	o	--
	7	ND	++	o	+	o	o	o		o	o	o	o	o	o	o	o	--
	8	ND	++	o	o	o	o	o	o		o	-	o	-	o	-	o	--
	9	ND	++	++	++	++	o	o	o	o		o	o	o	o	o	o	-
	10	ND	++	++	++	++	+	+	o	+	o		o	o	o	o	+	-
	11	ND	++	++	++	++	o	o	o	o	o	o		o	o	o	o	-
	12	ND	++	++	++	++	+	+	o	+	o	o	o		o	o	o	--
	13	ND	++	++	++	+	o	o	o	o	o	o	o	o		o	o	--
	221	ND	++	++	++	++	+	+	o	+	o	o	o	o	o		o	--
	225	ND	++	+	o	o	o	o	o	o	o	-	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	+	+	+	++	++	++	++	

Table M-1a
(continued)

LCIC	Comparison Area	Median Conc. (ppb)	EDA Neighborhoods													Comparison Areas		
			1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
TOTALS	++		105	50	43	31	16	7	8	8	5	10	5	4	14	13	10	0
	+		0	26	15	13	12	6	9	10	1	5	1	6	7	5	10	0
	o		12	37	53	63	83	73	90	87	80	73	65	63	75	67	81	22
	-		2	0	2	4	1	13	5	7	9	15	14	8	4	11	7	10
	--		1	7	7	9	8	21	8	8	25	17	35	40	20	24	12	88
	All Symbols		120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

---

a.
++ = Column neighborhood/comparison area > Row neighborhood/comparison area at 0.01 significance level.
+ = Column neighborhood/comparison area > Row neighborhood/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column neighborhood/comparison area < Row neighborhood/comparison area at 0.05 significance level.
-- = Column neighborhood/comparison area < Row neighborhood/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. The First entry in each column is median concentration; ND indicates non-detect.

d. 221 = Census Tract 221.
225 = Census Tract 225.
C&T Cheektowaga and Tonawanda.

e. Based on observations classified as Good.

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Table M-1b
TWO-SIDED p-VALUES FOR NONPARAMETRIC UNIVARIATE NEIGHBORHOOD/COMPARISON AREA TO NEIGHBORHOOD/COMPARISON AREA COMPARISONS[a,b]

LCIC	Neigh-borhood/ Comparison Area	EDA Neighborhoods													Comparison Areas		
		1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
DCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.276	0.236	0.407	0.003	0.486	0.730	0.009	0.225	0.009	0.100	0.167	0.275	0.241	0.004
	3	0.000	0.276	1.000	0.470	0.382	0.136	0.471	0.308	0.536	0.365	0.486	0.664	0.589	0.445	0.694	0.120
	4	0.000	0.236	0.470	1.000	0.679	0.021	0.391	0.667	0.098	0.907	0.112	0.170	0.563	0.814	0.529	0.006
	5	0.000	0.407	0.382	0.679	1.000	0.038	0.952	0.921	0.363	0.559	0.091	0.269	0.959	0.582	0.981	0.018
	6	0.000	0.003	0.136	0.021	0.038	1.000	0.009	0.043	0.824	0.004	0.796	0.258	0.020	0.003	0.025	0.915
	7	0.000	0.486	0.471	0.391	0.952	0.009	1.000	0.659	0.045	0.753	0.029	0.240	0.300	0.708	0.482	0.055
	8	0.000	0.730	0.308	0.667	0.921	0.043	0.659	1.000	0.053	0.967	0.013	0.028	0.618	0.828	0.359	0.021
	9	0.000	0.009	0.536	0.098	0.363	0.824	0.045	0.053	1.000	0.079	0.685	0.957	0.136	0.060	0.356	0.976
	10	0.000	0.225	0.365	0.907	0.559	0.004	0.753	0.967	0.079	1.000	0.004	0.147	0.429	0.728	0.742	0.023
	11	0.000	0.009	0.486	0.112	0.091	0.796	0.029	0.013	0.685	0.004	1.000	0.645	0.075	0.002	0.168	0.640
	12	0.000	0.100	0.664	0.170	0.269	0.258	0.240	0.028	0.957	0.147	0.645	1.000	0.389	0.109	0.529	0.091
	13	0.000	0.167	0.589	0.563	0.959	0.020	0.300	0.618	0.136	0.429	0.075	0.389	1.000	0.780	0.611	0.078
	221	0.000	0.275	0.445	0.814	0.582	0.003	0.708	0.828	0.060	0.728	0.002	0.109	0.780	1.000	0.757	0.007
	225	0.000	0.241	0.694	0.529	0.981	0.025	0.482	0.359	0.356	0.742	0.168	0.529	0.611	0.757	1.000	0.194
	C&T	0.000	0.004	0.120	0.006	0.018	0.915	0.055	0.021	0.976	0.023	0.640	0.091	0.078	0.007	0.194	1.000
TCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.246	0.131	0.092	0.000	0.231	0.049	0.001	0.016	0.000	0.000	0.000	0.002	0.042	0.000
	3	0.000	0.246	1.000	0.814	0.743	0.000	0.283	0.222	0.001	0.050	0.000	0.000	0.002	0.039	0.035	0.000
	4	0.000	0.131	0.814	1.000	0.986	0.000	0.991	0.286	0.004	0.043	0.000	0.000	0.011	0.039	0.046	0.000
	5	0.000	0.092	0.743	0.986	1.000	0.005	0.834	0.305	0.102	0.205	0.000	0.001	0.034	0.070	0.275	0.000
	6	0.000	0.000	0.000	0.000	0.005	1.000	0.081	0.134	0.925	0.303	0.132	0.557	0.090	0.011	0.077	0.000
	7	0.000	0.231	0.283	0.991	0.834	0.081	1.000	0.448	0.027	0.525	0.017	0.013	0.137	0.393	0.271	0.000
	8	0.000	0.049	0.222	0.286	0.305	0.134	0.448	1.000	0.180	0.703	0.005	0.022	0.453	0.504	0.846	0.000
	9	0.000	0.001	0.001	0.004	0.102	0.925	0.027	0.180	1.000	0.049	0.499	0.451	0.059	0.006	0.090	0.000
	10	0.000	0.016	0.050	0.043	0.205	0.303	0.525	0.703	0.049	1.000	0.007	0.001	0.962	0.224	0.714	0.000
	11	0.000	0.000	0.000	0.000	0.000	0.132	0.017	0.005	0.499	0.007	1.000	0.879	0.005	0.000	0.073	0.000
	12	0.000	0.000	0.000	0.000	0.001	0.557	0.013	0.022	0.451	0.001	0.879	1.000	0.002	0.000	0.009	0.000
	13	0.000	0.000	0.002	0.011	0.034	0.090	0.137	0.453	0.059	0.962	0.005	0.002	1.000	0.167	0.906	0.000
	221	0.000	0.002	0.039	0.039	0.070	0.011	0.393	0.504	0.006	0.224	0.000	0.000	0.167	1.000	0.368	0.000
	225	0.000	0.042	0.035	0.046	0.275	0.077	0.271	0.846	0.090	0.714	0.073	0.009	0.906	0.368	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Table M-1b
(continued)

LCIC	Neighborhood/ Comparison Area	EDA Neighborhoods 1	2	3	4	5	6	7	8	9	10	11	12	13	Comparison Areas 221	225	C&T
TeCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.274	0.039	0.120	0.000	0.018	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.000
	3	0.000	0.274	1.000	0.383	0.343	0.000	0.027	0.019	0.000	0.011	0.000	0.000	0.000	0.000	0.001	0.000
	4	0.000	0.039	0.383	1.000	0.987	0.000	0.206	0.053	0.000	0.030	0.000	0.000	0.000	0.000	0.012	0.000
	5	0.000	0.120	0.343	0.987	1.000	0.000	0.235	0.034	0.001	0.055	0.000	0.000	0.001	0.001	0.069	0.000
	6	0.000	0.000	0.000	0.000	0.000	1.000	0.046	0.610	0.499	0.168	0.150	0.302	0.084	0.040	0.054	0.000
	7	0.000	0.018	0.027	0.206	0.235	0.046	1.000	0.459	0.113	0.911	0.012	0.009	0.372	0.246	0.636	0.000
	8	0.000	0.001	0.019	0.053	0.034	0.610	0.459	1.000	0.418	0.785	0.062	0.077	0.583	0.546	0.316	0.000
	9	0.000	0.000	0.000	0.000	0.001	0.499	0.113	0.418	1.000	0.013	0.555	0.634	0.055	0.029	0.061	0.000
	10	0.000	0.001	0.011	0.030	0.055	0.168	0.911	0.785	0.013	1.000	0.001	0.001	0.509	0.342	0.769	0.000
	11	0.000	0.000	0.000	0.000	0.000	0.150	0.012	0.062	0.555	0.001	1.000	0.789	0.008	0.001	0.038	0.000
	12	0.000	0.000	0.000	0.000	0.000	0.302	0.009	0.077	0.634	0.001	0.789	1.000	0.001	0.001	0.001	0.000
	13	0.000	0.000	0.000	0.000	0.001	0.084	0.372	0.583	0.055	0.509	0.008	0.001	1.000	0.676	0.836	0.000
	221	0.000	0.000	0.000	0.000	0.001	0.040	0.246	0.546	0.029	0.342	0.001	0.001	0.676	1.000	0.346	0.000
	225	0.000	0.002	0.001	0.012	0.069	0.054	0.636	0.316	0.061	0.769	0.038	0.001	0.836	0.346	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
CNP	1	1.000	0.948	0.901	0.775	0.958	0.275	0.506	0.948	0.497	0.619	0.806	0.097	0.036	0.110	0.047	0.693
	2	0.948	1.000	0.779	0.800	0.444	0.803	0.636	0.868	0.589	0.354	0.841	0.222	0.133	0.232	0.078	0.645
	3	0.901	0.779	1.000	0.771	0.617	0.761	0.637	0.435	0.136	0.678	0.752	0.119	0.018	0.120	0.041	0.989
	4	0.775	0.800	0.771	1.000	0.962	0.149	0.725	0.775	0.497	0.714	0.549	0.037	0.002	0.086	0.010	0.835
	5	0.958	0.444	0.617	0.962	1.000	0.575	0.939	0.991	0.682	0.494	0.570	0.456	0.048	0.214	0.093	0.770
	6	0.275	0.803	0.761	0.149	0.575	1.000	0.598	0.818	0.636	0.194	0.166	0.303	0.024	0.597	0.107	0.103
	7	0.506	0.636	0.637	0.725	0.939	0.598	1.000	0.630	0.678	0.435	0.223	0.070	0.073	0.371	0.060	0.596
	8	0.948	0.868	0.435	0.775	0.991	0.818	0.630	1.000	0.053	0.422	0.569	0.244	0.022	0.346	0.139	0.772
	9	0.497	0.589	0.136	0.497	0.682	0.636	0.678	0.053	1.000	0.124	0.279	0.400	0.131	0.649	0.078	0.454
	10	0.619	0.354	0.678	0.714	0.494	0.194	0.435	0.422	0.124	1.000	0.701	0.053	0.003	0.089	0.018	0.478
	11	0.806	0.841	0.752	0.549	0.570	0.166	0.223	0.569	0.279	0.701	1.000	0.017	0.013	0.017	0.025	0.401
	12	0.097	0.222	0.119	0.037	0.456	0.303	0.070	0.244	0.400	0.053	0.017	1.000	0.159	0.866	0.875	0.034
	13	0.036	0.133	0.018	0.002	0.048	0.024	0.073	0.022	0.131	0.003	0.013	0.159	1.000	0.316	0.345	0.001
	221	0.110	0.232	0.120	0.086	0.214	0.597	0.371	0.346	0.649	0.089	0.017	0.866	0.316	1.000	0.824	0.091
	225	0.047	0.078	0.041	0.010	0.093	0.107	0.060	0.139	0.078	0.018	0.025	0.875	0.345	0.824	1.000	0.010
	C&T	0.693	0.645	0.989	0.835	0.770	0.103	0.596	0.772	0.454	0.478	0.401	0.034	0.001	0.091	0.010	1.000

Table M-1b
(continued)

LCIC	Neighborhood/ Comparison Area	EDA Neighborhoods													Comparison Areas		
		1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
a-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.568	0.036	0.141	0.018	0.054	0.010	0.005	0.003	0.000	0.000	0.000	0.000	0.017	0.000
	3	0.000	0.568	1.000	0.028	0.372	0.010	0.010	0.010	0.002	0.002	0.000	0.000	0.000	0.000	0.003	0.000
	4	0.000	0.036	0.028	1.000	0.950	0.242	0.133	0.323	0.122	0.047	0.003	0.005	0.174	0.134	0.213	0.000
	5	0.000	0.141	0.372	0.950	1.000	0.625	0.082	0.566	0.438	0.143	0.026	0.108	0.341	0.143	0.610	0.000
	6	0.000	0.018	0.010	0.242	0.625	1.000	0.332	0.984	0.915	0.917	0.111	0.172	0.822	0.630	0.410	0.000
	7	0.000	0.054	0.010	0.133	0.082	0.332	1.000	0.322	0.948	0.305	0.795	0.969	0.408	0.354	0.391	0.000
	8	0.000	0.010	0.010	0.323	0.566	0.984	0.322	1.000	0.908	0.956	0.219	0.523	0.607	0.381	0.538	0.000
	9	0.000	0.005	0.002	0.122	0.438	0.915	0.948	0.908	1.000	0.794	0.343	0.084	0.870	0.517	0.804	0.000
	10	0.000	0.003	0.002	0.047	0.143	0.917	0.305	0.956	0.794	1.000	0.315	0.124	0.671	0.743	0.748	0.000
	11	0.000	0.000	0.000	0.003	0.026	0.111	0.795	0.219	0.343	0.315	1.000	0.968	0.114	0.045	0.555	0.000
	12	0.000	0.000	0.000	0.005	0.108	0.172	0.969	0.523	0.084	0.124	0.968	1.000	0.111	0.093	0.167	0.000
	13	0.000	0.000	0.000	0.174	0.341	0.822	0.408	0.607	0.870	0.671	0.114	0.111	1.000	0.468	0.616	0.000
	221	0.000	0.000	0.000	0.134	0.143	0.630	0.354	0.381	0.517	0.743	0.045	0.093	0.468	1.000	0.346	0.000
	225	0.000	0.017	0.003	0.213	0.610	0.410	0.391	0.538	0.804	0.748	0.555	0.167	0.616	0.346	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
d-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.126	0.053	0.002	0.001	0.003	0.016	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000
	3	0.000	0.126	1.000	0.785	0.060	0.003	0.104	0.189	0.016	0.000	0.001	0.000	0.001	0.000	0.006	0.000
	4	0.000	0.053	0.785	1.000	0.133	0.030	0.275	0.365	0.045	0.001	0.010	0.002	0.049	0.000	0.067	0.000
	5	0.000	0.002	0.060	0.133	1.000	0.592	0.700	0.661	0.828	0.031	0.167	0.198	0.777	0.043	0.906	0.000
	6	0.000	0.001	0.003	0.030	0.592	1.000	0.734	0.431	0.481	0.062	0.250	0.198	0.839	0.032	0.573	0.000
	7	0.000	0.003	0.104	0.275	0.700	0.734	1.000	0.549	0.548	0.039	0.138	0.161	0.404	0.049	0.472	0.000
	8	0.000	0.016	0.189	0.365	0.661	0.431	0.549	1.000	0.577	0.024	0.128	0.065	0.544	0.006	0.405	0.000
	9	0.000	0.001	0.016	0.045	0.828	0.481	0.548	0.577	1.000	0.103	0.588	0.444	0.641	0.216	0.701	0.001
	10	0.000	0.000	0.000	0.001	0.031	0.062	0.039	0.024	0.103	1.000	0.280	0.337	0.063	0.670	0.098	0.107
	11	0.000	0.000	0.001	0.010	0.167	0.250	0.138	0.128	0.588	0.280	1.000	0.827	0.425	0.905	0.541	0.005
	12	0.000	0.000	0.000	0.002	0.198	0.198	0.161	0.065	0.444	0.337	0.827	1.000	0.187	0.319	0.413	0.011
	13	0.000	0.000	0.001	0.049	0.777	0.839	0.404	0.544	0.641	0.063	0.425	0.187	1.000	0.071	0.772	0.000
	221	0.000	0.000	0.000	0.000	0.043	0.032	0.049	0.006	0.216	0.670	0.905	0.319	0.071	1.000	0.075	0.070
	225	0.000	0.001	0.006	0.067	0.906	0.573	0.472	0.405	0.701	0.098	0.541	0.413	0.772	0.075	1.000	0.001
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.107	0.005	0.011	0.000	0.070	0.001	1.000

Table M-1b
(continued)

LCIC	Neighborhood/ Comparison Area	EDA Neighborhoods													Comparison Areas		
		1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
b-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.106	0.901	0.862	0.586	0.385	0.243	0.005	0.145	0.015	0.000	0.084	0.005	0.570	0.000
	3	0.000	0.106	1.000	0.179	0.169	0.084	0.015	0.115	0.001	0.021	0.001	0.000	0.003	0.000	0.032	0.000
	4	0.000	0.901	0.179	1.000	0.700	0.296	0.299	0.220	0.005	0.087	0.014	0.000	0.199	0.000	0.409	0.000
	5	0.000	0.862	0.169	0.700	1.000	0.594	0.180	0.475	0.062	0.095	0.016	0.002	0.366	0.012	0.822	0.000
	6	0.000	0.586	0.084	0.296	0.594	1.000	0.272	0.549	0.013	0.381	0.078	0.000	0.574	0.016	0.755	0.000
	7	0.000	0.385	0.015	0.299	0.180	0.272	1.000	0.698	0.126	0.607	0.364	0.073	0.896	0.192	0.611	0.000
	8	0.000	0.243	0.115	0.220	0.475	0.549	0.698	1.000	0.192	0.505	0.396	0.047	0.673	0.323	0.667	0.000
	9	0.000	0.005	0.001	0.005	0.062	0.013	0.126	0.192	1.000	0.379	0.446	0.540	0.062	0.649	0.013	0.005
	10	0.000	0.145	0.021	0.087	0.095	0.381	0.607	0.505	0.379	1.000	0.413	0.014	0.528	0.137	0.681	0.000
	11	0.000	0.015	0.001	0.014	0.016	0.078	0.364	0.396	0.446	0.413	1.000	0.179	0.463	0.927	0.082	0.000
	12	0.000	0.000	0.000	0.000	0.002	0.000	0.073	0.047	0.540	0.014	0.179	1.000	0.001	0.197	0.001	0.037
	13	0.000	0.084	0.003	0.199	0.366	0.574	0.896	0.673	0.062	0.528	0.463	0.001	1.000	0.100	0.695	0.000
	221	0.000	0.005	0.000	0.000	0.012	0.016	0.192	0.323	0.649	0.137	0.927	0.197	0.100	1.000	0.033	0.000
	225	0.000	0.570	0.032	0.409	0.822	0.755	0.611	0.667	0.013	0.681	0.082	0.001	0.695	0.033	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.037	0.000	0.000	0.000	1.000
g-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.000	1.000	0.804	0.443	0.300	0.120	0.123	0.150	0.002	0.000	0.001	0.000	0.002	0.001	0.032	0.000
	3	0.000	0.804	1.000	0.642	0.374	0.027	0.045	0.194	0.004	0.000	0.004	0.000	0.002	0.000	0.060	0.000
	4	0.000	0.443	0.642	1.000	0.477	0.120	0.183	0.689	0.006	0.001	0.009	0.001	0.036	0.002	0.137	0.000
	5	0.000	0.300	0.374	0.477	1.000	0.609	0.595	0.763	0.159	0.016	0.090	0.027	0.330	0.031	0.746	0.000
	6	0.000	0.120	0.027	0.120	0.609	1.000	0.558	0.677	0.099	0.029	0.054	0.046	0.367	0.020	0.711	0.000
	7	0.000	0.123	0.045	0.183	0.595	0.558	1.000	0.384	0.206	0.143	0.397	0.510	0.709	0.596	0.560	0.001
	8	0.000	0.150	0.194	0.689	0.763	0.677	0.384	1.000	0.058	0.012	0.118	0.035	0.483	0.026	0.519	0.000
	9	0.000	0.002	0.004	0.006	0.159	0.099	0.206	0.058	1.000	0.646	0.913	0.630	0.218	0.688	0.080	0.014
	10	0.000	0.000	0.000	0.001	0.016	0.029	0.143	0.012	0.646	1.000	0.428	0.279	0.062	0.476	0.029	0.044
	11	0.000	0.001	0.004	0.009	0.090	0.054	0.397	0.118	0.913	0.428	1.000	0.891	0.279	0.688	0.153	0.010
	12	0.000	0.000	0.000	0.001	0.027	0.046	0.510	0.035	0.630	0.279	0.891	1.000	0.212	0.764	0.077	0.002
	13	0.000	0.002	0.002	0.036	0.330	0.367	0.709	0.483	0.218	0.062	0.279	0.212	1.000	0.201	0.484	0.000
	221	0.000	0.001	0.000	0.002	0.031	0.020	0.596	0.026	0.688	0.476	0.688	0.764	0.201	1.000	0.095	0.007
	225	0.000	0.032	0.060	0.137	0.746	0.711	0.560	0.519	0.080	0.029	0.153	0.077	0.484	0.095	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.014	0.044	0.010	0.002	0.000	0.007	0.000	1.000

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a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

WDR356/056/4

Table M-2a
RESULTS FOR NONPARAMETRIC MULTIVARIATE NEIGHBORHOOD/COMPARISON AREA TO NEIGHBORHOOD/COMPARISON AREA COMPARISIONS[a,b,c,d]

Neighborhood/ Comparison Area	EDA Neighborhoods													Comparison Areas		
	1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
1		--	--	--	--	--	--	-	--	--	--	--	--	--	--	--
2	++		o	o	o	--	o	--	--	-	--	--	--	--	-	--
3	++	o		o	o	-	o	o	--	o	--	--	--	--	--	--
4	++	o	o		o	--	o	o	--	-	--	--	--	--	-	--
5	++	o	o	o		o	o	o	-	o	--	--	--	--	o	--
6	++	++	+	++	o		+	o	o	o	o	o	+	++	o	--
7	++	o	o	o	o	-		o	o	o	o	o	o	o	o	--
8	+	++	o	o	o	o	o		-	o	o	o	-	o	o	--
9	++	++	++	++	+	o	o	+		o	o	o	o	+	o	--
10	++	+	o	+	o	o	o	o	o		o	--	+	+	o	--
11	++	++	++	++	++	o	o	o	o	o		o	o	+	o	--
12	++	++	++	++	++	o	o	o	o	++	o		+	++	o	--
13	++	++	++	++	++	-	o	+	o	-	o	-		-	o	--
221	++	++	++	++	++	--	o	o	-	-	-	--	+		+	--
225	++	+	++	+	o	o	o	o	o	o	o	o	o	-		--
C&T	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	

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a.
++ = Column neighborhood/comparison area > Row neighborhood/comparison area at 0.01 significance level.
+ = Column neighborhood/comparison area > Row neighborhood/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column neighborhood/comparison area < Row neighborhood/comparison area at 0.05 significance level.
-- = Column neighborhood/comparison area < Row neighborhood/comparison area at 0.01 significance level.

b. The direction of the difference between the EDA Neighborhoods and Comparison Areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

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Table M-2b

TWO-SIDED p-VALUES FOR NONPARAMETRIC MULTIVARIATE NEIGHBORHOOD/COMPARISON AREA TO NEIGHBORHOOD/COMPARISON AREA COMPARISONS[a,b]

Neighborhood/ Comparison Area	EDA Neighborhoods													Comparison Areas		
	1	2	3	4	5	6	7	8	9	10	11	12	13	221	225	C&T
1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	1.000	0.056	0.582	0.076	0.003	0.239	0.003	0.001	0.038	0.003	0.000	0.001	0.000	0.000	0.050
3	0.000	0.056	1.000	0.251	0.867	0.037	0.125	0.105	0.008	0.081	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.582	0.251	1.000	0.378	0.006	0.135	0.101	0.002	0.018	0.001	0.000	0.000	0.000	0.000	0.017
5	0.000	0.076	0.867	0.378	1.000	0.128	0.168	0.496	0.038	0.139	0.001	0.001	0.008	0.002	0.000	0.198
6	0.000	0.003	0.037	0.006	0.128	1.000	0.034	0.675	0.432	0.054	0.298	0.092	0.015	0.000	0.000	0.095
7	0.000	0.239	0.125	0.135	0.168	0.034	1.000	0.732	0.305	0.153	0.145	0.054	0.055	0.220	0.000	0.223
8	0.033	0.003	0.105	0.101	0.496	0.675	0.732	1.000	0.043	0.419	0.134	0.180	0.035	0.054	0.000	0.129
9	0.000	0.001	0.008	0.002	0.038	0.432	0.305	0.043	1.000	0.072	0.851	0.081	0.192	0.038	0.000	0.140
10	0.000	0.038	0.081	0.018	0.139	0.054	0.153	0.419	0.072	1.000	0.207	0.003	0.024	0.022	0.000	0.113
11	0.000	0.003	0.000	0.001	0.001	0.298	0.145	0.134	0.851	0.207	1.000	0.405	0.282	0.024	0.000	0.177
12	0.000	0.000	0.000	0.000	0.001	0.092	0.054	0.180	0.081	0.003	0.405	1.000	0.032	0.003	0.000	0.056
13	0.000	0.000	0.000	0.000	0.008	0.015	0.055	0.035	0.192	0.024	0.282	0.032	1.000	0.022	0.000	0.829
221	0.000	0.000	0.000	0.000	0.002	0.000	0.220	0.054	0.038	0.022	0.024	0.003	0.022	1.000	0.000	0.017
225	0.000	0.050	0.000	0.017	0.198	0.095	0.223	0.129	0.140	0.113	0.177	0.056	0.829	0.017	0.000	1.000
C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000

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[a] 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

[b] Based on observations classified as Good.

WDR356/058

Table M-3a
RESULTS FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH SAMPLING AREAS 2 and 3 REDEFINED^{a,b,c,d,e,f}

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2'	3'	4	5	6	7	221	225	C&T
			1.01	0.42	0.38	0.36	0.39	0.36	0.41	0.39	0.43	0.36
DCB	1	1.01		--	--	--	--	--	--	--	--	--
	2'	0.42	++		o	--	o	--	o	o	o	--
	3'	0.38	++	o		-	o	o	o	o	o	-
	4	0.36	++	++	+		+	o	++	++	+	o
	5	0.39	++	o	o	-		-	o	o	o	o
	6	0.36	++	++	o	o	+		+	++	o	o
	7	0.41	++	o	o	--	o	-		o	o	-
	221	0.39	++	o	o	--	o	--	o		o	--
	225	0.43	++	o	o	-	o	o	o	o		o
	C&T	0.36	++	++	+	o	o	o	+	++	c	
			8.67	0.98	0.83	0.43	0.52	0.37	0.58	0.65	0.60	0.13
TCB	1	8.67		--	--	--	--	--	--	--	--	--
	2'	0.98	++		o	--	--	--	--	--	-	--
	3'	0.83	++	o		--	-	--	--	-	-	--
	4	0.43	++	++	++		o	o	o	+	o	--
	5	0.52	++	++	+	o		--	o	o	o	--
	6	0.37	++	++	++	o	++		++	++	++	--
	7	0.58	++	++	++	o	o	--		o	o	--
	221	0.65	++	++	+	-	o	--	o		o	--
	225	0.60	++	+	+	o	o	--	o	o		--
	C&T	0.13	++	++	++	++	++	++	++	++	++	
			11.48	1.11	1.09	0.38	0.43	0.31	0.54	0.53	0.61	0.05
TeCB	1	11.48		--	--	--	--	--	--	--	--	--
	2'	1.11	++		o	--	--	--	--	--	--	--
	3'	1.09	++	o		--	--	--	--	--	--	--
	4	0.38	++	++	++		o	o	o	+	o	--
	5	0.43	++	++	++	o		--	o	o	o	--
	6	0.31	++	++	++	o	++		++	++	++	--
	7	0.54	++	++	++	o	o	--		o	o	--
	221	0.53	++	++	++	-	o	--	o		o	--
	225	0.61	++	++	++	o	o	--	o	o		--
	C&T	0.05	++	++	++	++	++	++	++	++	++	

Table M-3a
(Continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2'	3'	4	5	6	7	221	225	C&T
			ND	0.04	0.04	0.04	0.06	0.05	0.06	0.06	0.07	0.03
CNP	1	ND		o	o	o	o	o	o	o	+	o
	2'	0.04	o		o	o	o	o	+	o	++	o
	3'	0.04	o	o		o	o	o	o	o	+	o
	4	0.04	o	o	o		o	o	o	o	o	o
	5	0.06	o	o	o	o		o	o	o	+	o
	6	0.05	o	o	o	o	o		o	o	o	o
	7	0.06	o	-	o	o	o	o		o	o	-
	221	0.06	o	o	o	o	o	o	o		o	o
	225	0.07	-	--	-	o	-	o	o	o		-
	C&T	0.03	o	o	o	o	o	o	+	o	+	
			8.25	0.27	0.35	0.12	0.13	0.07	0.14	0.18	0.11	ND
a-BHC	1	8.25		--	--	--	--	--	--	--	--	--
	2'	0.27	++		o	o	--	--	--	--	-	--
	3'	0.35	++	o		o	--	--	--	--	-	--
	4	0.12	++	o	o		o	o	o	o	o	--
	5	0.13	++	++	++	o		o	o	o	o	--
	6	0.07	++	++	++	o	o		+	+	o	--
	7	0.14	++	++	++	o	o	-		o	o	--
	221	0.18	++	++	++	o	o	-	o		o	--
	225	0.11	++	+	+	o	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
			1.13	ND	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	1	1.13		--	--	--	--	--	--	--	--	--
	2'	ND	++		o	--	--	--	--	--	--	--
	3'	ND	++	o		-	o	--	--	--	-	--
	4	ND	++	++	+		o	o	o	-	o	--
	5	ND	++	++	o	o		-	o	-	o	--
	6	ND	++	++	++	o	+		o	o	o	--
	7	ND	++	++	++	o	o	o		o	o	--
	221	ND	++	++	++	+	+	o	o		o	o
	225	ND	++	++	+	o	o	o	o	o		--
	C&T	ND	++	++	++	++	++	++	++	o	++	

Table M-3a
(Continued)

LCIC	Sampling/ Comparison Area	Median Conc. (ppb)	EDA Sampling Areas							Comparison Areas		
			1	2'	3'	4	5	6	7	221	225	C&T
			11.58	0.13	0.19	ND	ND	ND	ND	ND	ND	ND
b-BHC	1	11.58		--	--	--	--	--	--	--	--	--
	2'	0.13	++		o	o	--	--	-	--	o	--
	3'	0.19	++	o		o	--	--	--	--	o	--
	4	ND	++	o	o		o	--	o	-	o	--
	5	ND	++	++	++	o		o	o	o	o	--
	6	ND	++	++	++	++	o		++	o	++	--
	7	ND	++	+	++	o	o	--		o	o	--
	221	ND	++	++	++	+	o	o	o		+	--
	225	ND	++	o	o	o	o	--	o	-		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
			1.73	0.01	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC	1	1.73		--	--	--	--	--	--	--	--	--
	2'	0.01	++		o	o	--	--	--	--	-	--
	3'	ND	++	o		o	-	--	--	--	o	--
	4	ND	++	o	o		o	-	o	-	o	--
	5	ND	++	++	+	o		o	o	o	o	--
	6	ND	++	++	++	+	o		o	o	+	--
	7	ND	++	++	++	o	o	o		o	o	--
	221	ND	++	++	++	+	o	o	o		o	--
	225	ND	++	+	o	o	o	-	o	o		--
	C&T	ND	++	++	++	++	++	++	++	++	++	
TOTALS	++		63	37	29	7	8	6	10	10	10	0
	+		0	4	9	4	4	0	5	3	7	0
	o		8	22	26	40	41	27	38	35	39	12
	-		1	1	1	6	3	7	1	6	6	4
	--		0	8	7	15	16	32	18	18	10	56
All Symbols			72	72	72	72	72	72	72	72	72	72

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[a] ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

[b] All test results reported are based on two-sided p-values.

[c] The First entry in each column is median concentration; ND indicates non-detect.

[d] 221 = Census Tract 221.
225 = Census Tract 225.
C&T Cheektowaga and Tonawanda.

[e] Based on observations classified as Good.

[f] EDA Sampling Area 2' = EDA Neighborhoods 2 and 4; EDA Sampling Area 3' = EDA Neighborhoods 3 and 5.

WDR356/059/3

Table M-3b
TWO-SIDED p-VALUES FOR NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH SAMPLING AREAS 2 AND 3 REDEFINED^{a,b,c}

LCIC	Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
		1	2'	3'	4	5	6	7	221	225	C&T
DCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2'	0.000	1.000	0.384	0.001	0.231	0.008	0.174	0.391	0.214	0.001
	3'	0.000	0.384	1.000	0.020	0.982	0.197	0.545	0.453	0.877	0.019
	4	0.000	0.001	0.020	1.000	0.029	0.349	0.003	0.003	0.025	0.915
	5	0.000	0.231	0.982	0.029	1.000	0.044	0.639	0.617	0.779	0.058
	6	0.000	0.008	0.197	0.349	0.044	1.000	0.035	0.009	0.312	0.146
	7	0.000	0.174	0.545	0.003	0.639	0.035	1.000	0.992	0.556	0.022
	221	0.000	0.391	0.453	0.003	0.617	0.009	0.992	1.000	0.757	0.007
	225	0.000	0.214	0.877	0.025	0.779	0.312	0.556	0.757	1.000	0.194
	C&T	0.000	0.001	0.019	0.915	0.058	0.146	0.022	0.007	0.194	1.000
TCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2'	0.000	1.000	0.371	0.000	0.003	0.000	0.000	0.002	0.011	0.000
	3'	0.000	0.371	1.000	0.000	0.017	0.000	0.001	0.018	0.035	0.000
	4	0.000	0.000	0.000	1.000	0.140	0.219	0.089	0.011	0.077	0.000
	5	0.000	0.003	0.017	0.140	1.000	0.002	0.964	0.268	0.828	0.000
	6	0.000	0.000	0.000	0.219	0.002	1.000	0.000	0.000	0.005	0.000
	7	0.000	0.000	0.001	0.089	0.964	0.000	1.000	0.123	0.808	0.000
	221	0.000	0.002	0.018	0.011	0.268	0.000	0.123	1.000	0.368	0.000
	225	0.000	0.011	0.035	0.077	0.828	0.005	0.808	0.368	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
TeCB	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2'	0.000	1.000	0.595	0.000	0.000	0.000	0.000	0.000	0.001	0.000
	3'	0.000	0.595	1.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
	4	0.000	0.000	0.000	1.000	0.404	0.127	0.055	0.040	0.054	0.000
	5	0.000	0.000	0.000	0.404	1.000	0.006	0.228	0.446	0.250	0.000
	6	0.000	0.000	0.000	0.127	0.006	1.000	0.000	0.000	0.000	0.000
	7	0.000	0.000	0.000	0.055	0.228	0.000	1.000	0.446	0.982	0.000
	221	0.000	0.000	0.000	0.040	0.446	0.000	0.446	1.000	0.346	0.000
	225	0.000	0.001	0.001	0.054	0.250	0.000	0.982	0.346	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
CNP	1	1.000	0.855	0.996	0.275	0.519	0.175	0.181	0.110	0.047	0.693
	2'	0.855	1.000	0.715	0.279	0.454	0.103	0.050	0.052	0.006	0.778
	3'	0.996	0.715	1.000	0.474	0.559	0.273	0.053	0.065	0.015	0.986
	4	0.275	0.279	0.474	1.000	0.599	0.789	0.246	0.597	0.107	0.103
	5	0.519	0.454	0.559	0.599	1.000	0.305	0.166	0.311	0.018	0.605
	6	0.175	0.103	0.273	0.789	0.305	1.000	0.368	0.383	0.322	0.193
	7	0.181	0.050	0.053	0.246	0.166	0.368	1.000	0.965	0.762	0.018
	221	0.110	0.052	0.065	0.597	0.311	0.383	0.965	1.000	0.824	0.091
	225	0.047	0.006	0.015	0.107	0.018	0.322	0.762	0.824	1.000	0.010
	C&T	0.693	0.778	0.986	0.103	0.605	0.193	0.018	0.091	0.010	1.000
a-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2'	0.000	1.000	0.501	0.051	0.002	0.000	0.000	0.005	0.031	0.000
	3'	0.000	0.501	1.000	0.059	0.002	0.000	0.000	0.001	0.024	0.000
	4	0.000	0.051	0.059	1.000	0.617	0.069	0.890	0.630	0.410	0.000
	5	0.000	0.002	0.002	0.623	1.000	0.164	0.516	0.270	0.942	0.000
	6	0.000	0.000	0.000	0.069	0.164	1.000	0.029	0.028	0.192	0.000
	7	0.000	0.000	0.000	0.890	0.516	0.029	1.000	0.509	0.577	0.000
	221	0.000	0.005	0.001	0.630	0.270	0.028	0.509	1.000	0.346	0.000
	225	0.000	0.031	0.024	0.410	0.942	0.192	0.577	0.346	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Table M-3b
(continued)

LCIC	Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
		1	2'	3'	4	5	6	7	221	225	C&T
d-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2'	0.000	1.000	0.082	0.003	0.001	0.000	0.000	0.000	0.003	0.000
	3'	0.000	0.082	1.000	0.016	0.113	0.000	0.000	0.000	0.039	0.000
	4	0.000	0.003	0.016	1.000	0.829	0.108	0.351	0.032	0.573	0.000
	5	0.000	0.001	0.113	0.829	1.000	0.034	0.169	0.015	0.560	0.000
	6	0.000	0.000	0.000	0.108	0.034	1.000	0.474	0.563	0.372	0.008
	7	0.000	0.000	0.000	0.351	0.169	0.474	1.000	0.206	0.667	0.002
	221	0.000	0.000	0.000	0.032	0.015	0.563	0.206	1.000	0.075	0.070
	225	0.000	0.003	0.039	0.573	0.560	0.372	0.667	0.075	1.000	0.001
	C&T	0.000	0.000	0.000	0.000	0.000	0.008	0.002	0.070	0.001	1.000
b-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2'	0.000	1.000	0.399	0.353	0.004	0.000	0.020	0.000	0.366	0.000
	3'	0.000	0.399	1.000	0.165	0.002	0.000	0.006	0.000	0.118	0.000
	4	0.000	0.353	0.165	1.000	0.051	0.000	0.411	0.016	0.755	0.000
	5	0.000	0.004	0.002	0.051	1.000	0.099	0.293	0.453	0.118	0.000
	6	0.000	0.000	0.000	0.000	0.099	1.000	0.002	0.247	0.001	0.004
	7	0.000	0.020	0.006	0.411	0.293	0.002	1.000	0.072	0.632	0.000
	221	0.000	0.000	0.000	0.016	0.453	0.247	0.072	1.000	0.033	0.000
	225	0.000	0.366	0.118	0.755	0.118	0.001	0.632	0.033	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	1.000
g-BHC	1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2'	0.000	1.000	0.752	0.079	0.003	0.000	0.000	0.000	0.030	0.000
	3'	0.000	0.752	1.000	0.081	0.016	0.000	0.000	0.001	0.141	0.000
	4	0.000	0.079	0.081	1.000	0.404	0.011	0.098	0.020	0.711	0.000
	5	0.000	0.003	0.016	0.404	1.000	0.158	0.466	0.278	0.461	0.000
	6	0.000	0.000	0.000	0.011	0.158	1.000	0.434	0.921	0.835	0.002
	7	0.000	0.000	0.000	0.098	0.466	0.434	1.000	0.457	0.140	0.000
	221	0.000	0.000	0.001	0.020	0.278	0.921	0.457	1.000	0.095	0.007
	225	0.000	0.030	0.141	0.711	0.461	0.035	0.140	0.095	1.000	0.000
	C&T	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.007	0.000	1.000

---

a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

c. EDA Sampling area 2' = EDA Neighborhoods 2 and 4;
EDA Sampling area 3' = EDA Neighborhoods 3 and 5.

Table M-3c
SUMMARY OF NONPARAMETRIC UNIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH SAMPLING AREAS 2 and 3 REDEFINED[a,b,c,d,e]

Totals Over All LCICs

Sampling/ Comparison Area		EDA Sampling Areas							Comparison Areas		
		1	2'	3'	4	5	6	7	221	225	C&T
1	++		0	0	0	0	0	0	0	0	0
	+		0	0	0	0	0	0	0	1	0
	o		1	1	1	1	1	1	1	0	1
	-		0	0	0	0	0	0	0	0	0
	--		7	7	7	7	7	7	7	7	7
2'	++	7		0	0	0	0	0	0	1	0
	+	0		0	0	0	0	1	0	0	1
	o	1		8	4	2	1	1	2	2	0
	-	0		0	0	0	0	1	0	4	0
	--	0		0	4	6	7	5	6	2	7
3'	++	7	0		0	0	0	0	0	0	0
	+	0	0		0	0	0	0	2	1	0
	o	1	8		4	3	2	2	2	3	1
	-	0	0		2	2	1	0	0	3	1
	--	0	0		2	3	5	6	4	1	6
4	++	7	4	2		0	0	1	1	0	0
	+	0	0	2		0	0	0	0	1	0
	o	1	4	4		7	6	7	2	6	2
	-	0	0	0		1	1	0	5	1	0
	--	0	0	0		0	1	0	0	0	6
5	++	7	5	3	0		0	0	0	0	0
	+	0	0	2	0		0	1	1	0	0
	o	1	2	3	7		4	7	7	8	2
	-	0	1	0	1		2	0	0	0	0
	--	0	0	0	0		2	0	0	0	6
6	++	7	7	5	1	2		3	3	3	0
	+	0	0	0	1	2		0	0	0	0
	o	1	1	2	6	4		3	3	4	2
	-	0	0	1	0	0		2	2	1	0
	--	0	0	0	0	0		0	0	0	6
7	++	7	5	6	0	0	0		0	0	0
	+	0	1	0	0	0	0		0	0	0
	o	1	1	2	7	8	3		8	8	0
	-	0	0	0	1	0	2		0	0	2
	--	0	0	0	0	0	3		0	0	6
221	++	7	6	5	0	0	0	0		0	0
	+	0	0	1	3	1	0	0		0	0
	o	1	2	2	2	7	4	8		7	2
	-	0	0	0	2	0	1	0		1	0
	--	0	0	0	1	0	3	0		0	6
225	++	7	2	1	0	0	0	0	0		0
	+	0	3	3	0	0	0	0	0		0
	o	0	2	3	7	7	4	8	7		1
	-	1	0	1	1	1	1	0	1		1
	--	0	1	0	0	0	3	0	0		6

Table M-3c
(continued)

Sampling/ Comparison Area		Totals Over All LCICs									
		EDA Sampling Areas							Comparison Areas		
		1	2'	3'	4	5	6	7	221	225	C&T
C&T	++	7	7	6	6	6	6	6	6	6	
	+	0	0	1	0	0	0	0	0	0	
	o	1	1	1	2	2	2	0	2	1	
	-	0	0	0	0	0	0	2	0	1	
	--	0	0	0	0	0	0	0	0	0	

---

a. ++: Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level
+: Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level
o: No significant difference at 0.05 significance level
-: Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level
--: Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level

b. All test results reported are based on two-sided p-values.

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

e. EDA Sampling area 2' = EDA Neighborhoods 2 and 4;
EDA Sampling area 3' = EDA Neighborhoods 3 and 5.

WDR356/061/2

Table M-4a
RESULTS FOR NONPARAMETRIC MULTIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH SAMPLING AREAS 2 AND 3 REDEFINED[a,b,c,d,e]

Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
	1	2'	3'	4	5	6	7	221	225	C&T
1		--	--	--	--	--	--	--	--	--
2	++		-	--	--	--	--	--	--	--
3	++	+		--	--	--	--	--	--	--
4	++	++	++		o	o	++	++	o	--
5	++	++	++	o		o	+	-	+	--
6	++	++	++	o	o		++	++	+	--
7	++	++	++	--	-	--		--	o	--
221	++	++	++	--	+	--	++		+	--
225	++	++	++	o	-	-	o	-		--
C&T	++	++	++	++	++	++	++	++	++	

---

a.
++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. The direction of the difference between the EDA Neighborhoods and Comparison Areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

e. EDA Sampling area 2' = EDA Neighborhoods 2 and 4;
EDA Sampling area 3' = EDA Neighborhoods 3 and 5.

WDR356/062

Table M-4b
TWO-SIDED p-VALUES FOR NONPARAMETRIC MULTIVARIATE SAMPLING/COMPARISON AREA TO SAMPLING/COMPARISON AREA COMPARISONS WITH SAMPLING AREAS 2 AND 3 REDEFINED[a,b,c]

Sampling/ Comparison Area	EDA Sampling Areas							Comparison Areas		
	1	2'	3'	4	5	6	7	221	225	C&T
1	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	1.000	0.027	0.000	0.000	0.000	0.000	0.000	0.002	0.000
3	0.000	0.027	1.000	0.006	0.001	0.000	0.000	0.000	0.001	0.000
4	0.000	0.000	0.006	1.000	0.084	0.086	0.009	0.000	0.095	0.000
5	0.000	0.000	0.001	0.084	1.000	0.220	0.028	0.037	0.023	0.000
6	0.000	0.000	0.000	0.086	0.220	1.000	0.008	0.001	0.019	0.000
7	0.000	0.000	0.000	0.009	0.028	0.008	1.000	0.004	0.778	0.000
221	0.000	0.000	0.000	0.000	0.037	0.001	0.004	1.000	0.017	0.000
225	0.000	0.002	0.001	0.095	0.023	0.019	0.778	0.017	1.000	0.000
C&T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

---

a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

c. EDA Sampling area 2' = EDA Neighborhoods 2 and 4.
EDA Sampling area 3' = EDA Neighborhoods 3 and 5.

WDR356/063

Table M-5a
RESULTS FOR NONPARAMETRIC UNIVARIATE
EDA SAMPLING AREA TO COMBINED COMPARISON AREAS COMPARISONS[a,b,c,d,e]

LCIC	Comparison Area	Median Conc. (ppb)	EDA Sampling Areas						
			1	2	3	4	5	6	7
DCB	Combined	0.38	1.01 ++	0.39 o	0.40 o	0.36 -	0.39 o	0.36 o	0.41 o
TCB	Combined	0.39	8.67 ++	0.91 ++	0.89 ++	0.43 o	0.52 ++	0.37 o	0.58 ++
TeCB	Combined	0.33	11.48 ++	1.17 ++	1.06 ++	0.38 +	0.43 ++	0.31 o	0.54 ++
CNP	Combined	0.06	ND o	0.04 o	0.04 o	0.04 o	0.06 o	0.05 o	0.06 o
a-BHC	Combined	ND	8.25 ++	0.40 ++	0.22 ++	0.12 ++	0.13 +	0.07 o	0.14 ++
d-BHC	Combined	ND	1.13 ++	0.04 ++	ND ++	ND ++	ND ++	ND o	ND o
b-BHC	Combined	ND	11.58 ++	0.20 ++	0.13 ++	ND ++	ND o	ND o	ND ++
g-BHC	Combined	ND	1.73 ++	0.09 ++	ND ++	ND ++	ND o	ND o	ND o
Totals	++		7	6	6	4	3	0	4
	+		0	0	0	1	1	0	0
	o		1	2	2	2	4	8	4
	-		0	0	o	1	0	0	0
	--		0	0	0	0	0	0	0
All Symbols			8	8	8	8	8	8	8

---

a.
++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. The first entry in each column is median concentration; ND indicates non-detect.

d. Combined comparison areas consist of Census Tract 221, Census Tract 225, and Cheektowaga and Tonawanda.

e. Based on observations classified as Good.

Table M-5b
TWO-SIDED p-VALUES FOR NONPARAMETRIC UNIVARIATE EDA SAMPLING AREA TO COMBINED COMPARISON AREAS COMPARISONS[a,b]

LCIC	Comparison Area	EDA Sampling Areas						
		1	2	3	4	5	6	7
DCB	Combined	0.000	0.144	0.108	0.033	0.495	0.385	0.203
TCB	Combined	0.000	0.000	0.000	0.110	0.001	0.618	0.000
TeCB	Combined	0.000	0.000	0.000	0.032	0.001	0.404	0.000
CNP	Combined	0.118	0.067	0.058	0.759	0.146	0.769	0.434
a-BHC	Combined	0.000	0.000	0.000	0.001	0.014	0.166	0.000
d-BHC	Combined	0.000	0.000	0.000	0.006	0.002	0.448	0.114
b-BHC	Combined	0.000	0.000	0.000	0.001	0.303	0.302	0.007
g-BHC	Combined	0.000	0.000	0.000	0.003	0.127	0.948	0.339

---

a. Combined comparison areas consist of Census Tract 221, Census Tract 225, and Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

Table M-6a

RESULTS FOR NONPARAMETRIC MULTIVARIATE EDA SAMPLING AREA TO COMBINED COMPARISON AREAS COMPARISON[a,b,c,d]

Comparison Area	EDA Sampling Areas 1	2	3	4	5	6	7
Combined	++	++	++	++	o	o	+

---

a.
++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level
o = No significant difference at 0.05 significance level
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level

b. The direction of the difference between the EDA Sampling Areas and combined Comparison Areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

c. Combined comparison areas consist of Census Tract 221, Census Tract 225, and Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

WDR356/066

Table M-6b

TWO-SIDED p-VALUES FOR NONPARAMETRIC MULTIVARIATE EDA SAMPLING AREA TO COMBINED COMPARISON AREAS COMPARISONS[a,b]

Comparison Area	EDA Sampling Areas						
	1	2	3	4	5	6	7
Combined	0.000	0.000	0.000	0.002	0.066	0.229	0.034

---

a. Combined comparison areas consist of Census Tract 221, Census Tract 225, and Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

WDR356/067

Table M-7a
RESULTS FOR NONPARAMETRIC UNIVARIATE COMBINED EDA SAMPLING AREAS TO COMPARISON AREA COMPARISONS[a,b,c,d,e]

LCIC	Comparison Area	Median Conc. (ppb)	Combined EDA Sampling Area
			0.40
DCB	221	0.39	o
	225	0.43	o
	C&T	0.36	++
			0.64
TCB	221	0.65	o
	225	0.60	o
	C&T	0.13	++
			0.61
TeCB	221	0.53	o
	225	0.61	o
	C&T	0.05	++
			0.05
CNP	221	0.06	o
	225	0.07	-
	C&T	0.03	o
			0.18
a-BHC	221	0.18	o
	225	0.11	o
	C&T	ND	++
			ND
d-BHC	221	ND	++
	225	ND	o
	C&T	ND	++
			ND
b-BHC	221	ND	++
	225	ND	o
	C&T	ND	++
			ND
g-BHC	221	ND	++
	225	ND	o
	C&T	ND	++
Totals	++		10
	+		0
	o		13
	-		1
	--		0
All Symbols			24

Table M-7a
(Continued)

---

a. ++ = Column sampling/comparison area > Row sampling/comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling/comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling/comparison area at 0.01 significance level.

b. All test results reported are based on two-sided p-values.

c. The First entry in each column is median concentration; ND indicates non-detect.

d. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

e. Based on observations classified as Good.

Table M-7b
TWO-SIDED p-VALUES FOR NONPARAMETRIC UNIVARIATE COMBINED EDA SAMPLING AREAS TO COMPARISON AREAS COMPARISONS[a,b]

LCIC	Comparison Area	Combined EDA Sampling Area
DCB	221	0.757
	225	0.573
	C&T	0.003
TCB	221	0.923
	225	0.372
	C&T	0.000
TeCB	221	0.108
	225	0.440
	C&T	0.000
CNP	221	0.164
	225	0.021
	C&T	0.244
a-BHC	221	0.186
	225	0.088
	C&T	0.000
d-BHC	221	0.001
	225	0.075
	C&T	0.000
b-BHC	221	0.002
	225	0.615
	C&T	0.000
g-BHC	221	0.005
	225	0.384
	C&T	0.000

---

a. Combined comparison areas consist of Census Tract 221, Census Tract 225, and Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

WDR356/069

Table M-8a
RESULTS FOR NONPARAMETRIC MULTIVARIATE COMBINED EDA SAMPLING AREAS TO COMPARISON AREAS COMPARISONS[a,b,c,d]

Comparison Areas	Combined EDA Sampling Area
221	++
225	o
C&T	++

---

a.
++ = Column sampling/comparison area > Row sampling/ comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/ comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling comparison area at 0.01 significance level.

b. The direction of the difference between the EDA Combined Sampling Areas and Comparison Areas is based on the sine of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

WDR356/070

Table M-8a
RESULTS FOR NONPARAMETRIC MULTIVARIATE COMBINED EDA SAMPLING AREAS TO COMPARISON AREAS COMPARISONS[a,b,c,d]

Comparison Areas	Combined EDA Sampling Area
221	++
225	o
C&T	++

---

a.
++ = Column sampling/comparison area > Row sampling/ comparison area at 0.01 significance level.
+ = Column sampling/comparison area > Row sampling/ comparison area at 0.05 significance level.
o = No significant difference at 0.05 significance level.
- = Column sampling/comparison area < Row sampling comparison area at 0.05 significance level.
-- = Column sampling/comparison area < Row sampling comparison area at 0.01 significance level.

b. The direction of the difference between the EDA Combined Sampling Areas and Comparison Areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

c. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

d. Based on observations classified as Good.

WDR356/070

Table M-8b
TWO SIDED p-VALUES FOR NONPARAMETRIC MULTIVARIATE COMBINED EDA SAMPLING AREAS TO COMPARISON AREAS COMPARISONS[a,b]

Comparison Area	Combined Sampling Area
221	0.000
225	0.180
C&T	0.000

---

a. 221 = Census Tract 221.
225 = Census Tract 225.
C&T = Cheektowaga and Tonawanda.

b. Based on observations classified as Good.

WDR356/071

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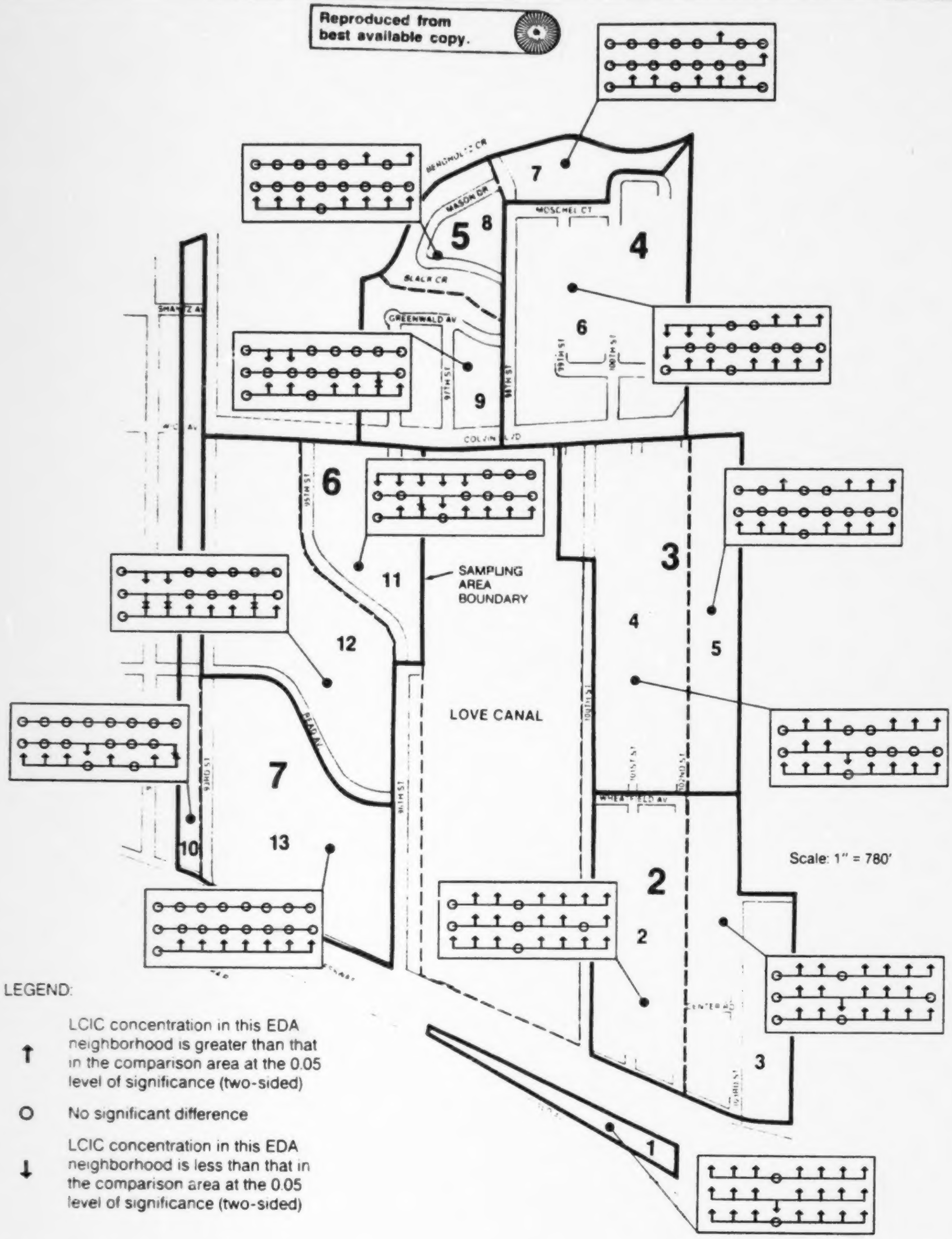

BERGHOLTZ CR
MASON DR
MOSCHEL CT
BLACK CR
GREENWALD AV
SHAWTZ AV
97TH ST
98TH ST
99TH ST
100TH ST
COLVIN BLVD
95TH ST
96TH ST
93RD ST
READ AV
100TH ST
101ST ST
102ND ST
WHEATFIELD AV
CENTER AV
SAMPLING AREA BOUNDARY
LOVE CANAL
1
2
3
4
5
6
7
8
9
10
11
12
13
2
3
4
5
6
7
Scale: 1" = 780'

LEGEND:

↑ LCIC concentration in this EDA neighborhood is greater than that in the comparison area at the 0.05 level of significance (two-sided)

○ No significant difference

↓ LCIC concentration in this EDA neighborhood is less than that in the comparison area at the 0.05 level of significance (two-sided)

Top Line = Census Tract 221

Middle Line = Census Tract 225

Bottom Line = Cheektowaga and Tonawanda

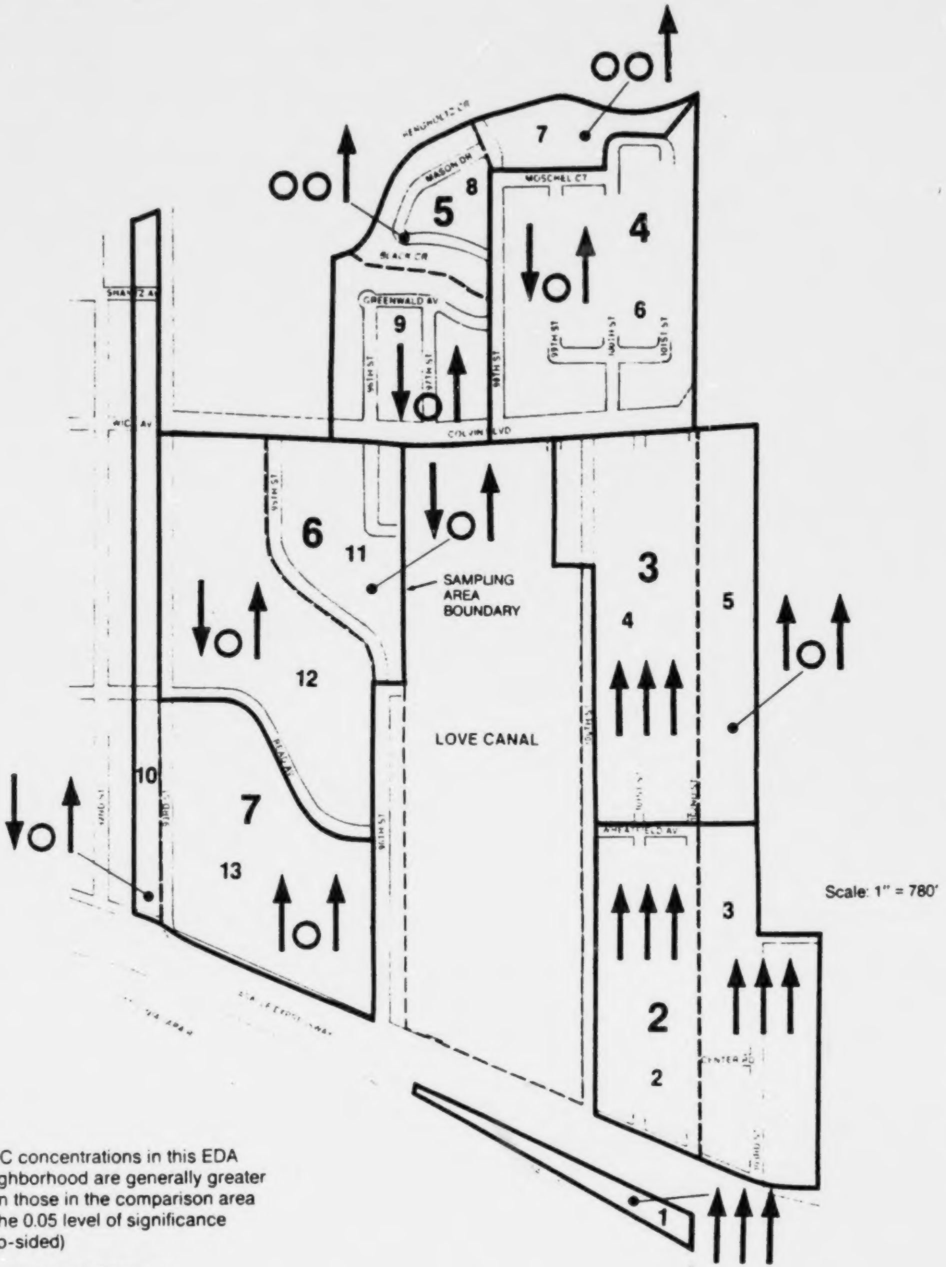
LCICs are in the following order on the line:

1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
1,2,3,4-Tetrachlorobenzene
2-Chloronapthalene
Alpha-BHC
Delta-BHC
Beta-BHC
Gamma-BHC

SOURCE: Neighborhood boundaries adapted from the Proposed Habitability Criteria document (NYSDOH and DHHS/CDC, 1986)

Figure M-1

SOIL ASSESSMENT -- INDICATOR CHEMICALS
SUMMARY OF UNIVARIATE COMPARISONS:
EDA NEIGHBORHOOD TO COMPARISON AREA


○○↑
7
HENDRICKS CR
MASON DR
8
5
○○↑
MOSCHEL CT
4
↓○↑
BLACK CR
GREENWALD AV
6
9
↓○↑
96TH ST
97TH ST
98TH ST
99TH ST
100TH ST
101ST ST
WICK AV
COLVIN BLVD
↓○↑
6
11
SAMPLING AREA BOUNDARY
↓○↑
12
3
4
5
↑↑↑
↑○↑
LOVE CANAL
10
↓○↑
7
13
↑○↑
READ AV
95TH ST
↑↑↑
3
2
2
↑↑↑
CENTER RD
1
↑↑↑
Scale: 1" = 780'

LEGEND:

↑ LCIC concentrations in this EDA neighborhood are generally greater than those in the comparison area at the 0.05 level of significance (two-sided)

○ No significant difference

↓ LCIC concentrations in this EDA neighborhood are generally less than those in the comparison area at the 0.05 level of significance (two-sided)

Comparison area symbols are in the following order:

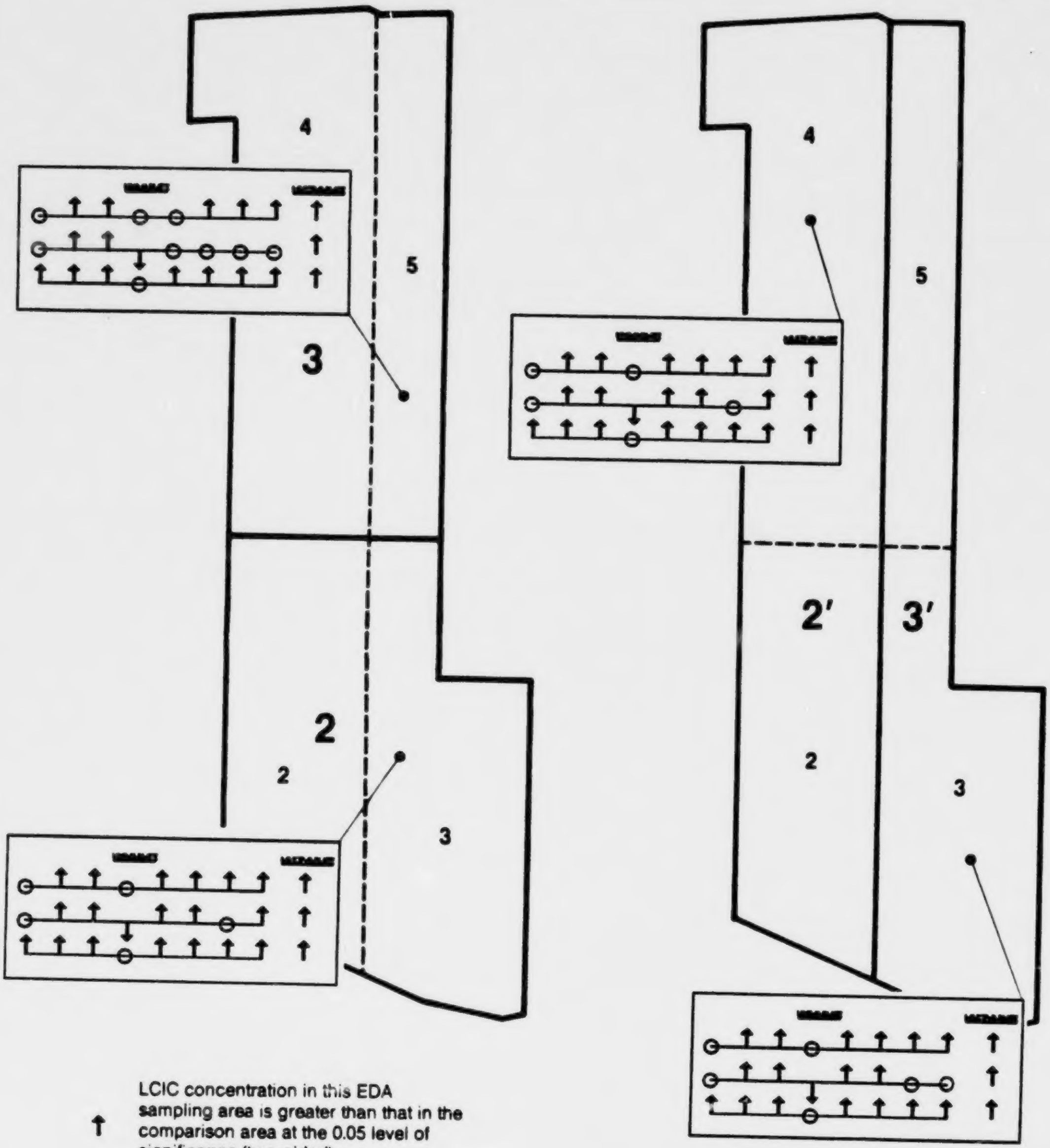
CT221 CT225 CK & TON

NOTE: The direction of the difference between the EDA neighborhoods and comparison areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Appendix B).

SOURCE: Neighborhood boundaries adapted from the Proposed Habitability Criteria document (NYSDOH and DHHS/CDC, 1986)

Figure M-2

SOIL ASSESSMENT -- INDICATOR CHEMICALS
SUMMARY OF MULTIVARIATE COMPARISONS
(LCICs AS A GROUP):
EDA NEIGHBORHOOD TO COMPARISON AREA



↑ LCIC concentration in this EDA sampling area is greater than that in the comparison area at the 0.05 level of significance (two-sided)

○ No significant difference

↓ LCIC concentration in this EDA sampling area is less than that in the comparison area at the 0.05 level of significance (two-sided)

Top Line = Census Tract 221

Middle Line = Census Tract 225

Bottom Line = Cheektowaga and Tonawanda

LCICs are in the following order on the line:

1, 2-Dichlorobenzene
1, 2, 4-Trichlorobenzene
1, 2, 3, 4-Tetrachlorobenzene
2-Chloronaphthalene
Alpha-BHC
Delta-BHC
Beta-BHC
Gamma-BHC

NOTE: The direction of the difference between the EDA and comparison areas is based on the sign of the sum of the elements of the 8 x 1 vector of rank-sums (Volume III, Appendix B).

Figure M-3

SOIL ASSESSMENT--INDICATOR CHEMICALS SUMMARY OF STATISTICAL (UNIVARIATE AND MULTIVARIATE) COMPARISONS: EDA SAMPLING AREAS 2 AND 3 TO COMPARISON AREAS AND EDA SAMPLING AREAS 2' AND 3' TO COMPARISON AREAS

APPENDIX N
List of Errata

Soil Assessment--Indicator Chemicals

Appendix N
LIST OF ERRATA
SOIL ASSESSMENT--INDICATOR CHEMICALS

Below is a list of errata for the subject report. Some of these are straightforward typographical errors, but others involve a change in content (Note--negative line numbers indicate number of lines from the bottom of the page.)

SECTIONS 1-6

Page	Line	Erratum
1-2	2	"The EDA comparison areas" should read "The EDA sampling areas"
1-3	1	"A total of 5320" should read "A total of 5329."
4-5	3	The random selection of sampling sites was done at the neighborhood level in the EDA, not at the sampling area level, as implied.
6-2		See attached Table 6-5, which shows the corrections.
6-45	3	The superscripts "a,b,c" should read "a,b,c,d"
6-48	3	The superscripts "a,b" should read "a,b,c"

APPENDIX A

There is a statement on page A-6, line 9, that ties the habitability decision to the "minimum unacceptable difference." It should be emphasized that the "delta" of one order of magnitude that was used in the design of the study (performed by CH2M HILL) is in no way related to any suggested rule for a habitability decision (which will be made by the Commissioner of Health for the State of New York.

Other Appendix A errata are as follows:

Page	Line	Erratum
A-3		"mean" should read "median"
A-5		"mean" should read "median"
A-8		Delete this page; it is a repeat of page A-6.
A-9	-19	"sampling area-" should read "EDA sampling area-"
	-16	"neighborhood" should read "sampling area"
	-13	"neighborhood" should read "sampling area"
	-12	"neighborhood" should read "sampling area"
A-10	10	"neighborhood" should read "sampling area"

APPENDIX B

Page	Line	Erratum
B-2	-14	The text after "analytical methods?" should start a new paragraph that is not part of question number 3.
B-11	24	"(Anderson and McLean)" should read "(Anderson and McLean, 1974)"
B-13	8	"extension to Eq. B.3" should read "extension to Eq. B.2"
B-14	-1	In the lower right-hand box, on the last line, the subscript "k" (lower case) should be "K" (upper case)
B-15	13	"sampling areas" should read "(sampling areas)"
B-16	5	"standard normal variable" should read "standard normal random variable"
B-20		Table B-4--LCICs are mislabeled. Labels should be: 1,2 Dichlorobenzene (1) 1,2,4 Trichlorobenzene (2) 1,2,3,4 Tetrachlorobenzene (3) Chloronaphthalene (4) alpha-BHC (5)

delta-BHC (6)
beta-BHC (7)
gamma-BHC (8)

APPENDIX F

In Figure F-1, "Blank QC" should be "Blind QC," and in Figure F-3, abbreviations "EMDC" should be "EMPC," and "Performance Handling Blank" should be "Preparation Handling Blank."

APPENDIX K

Tables K-1, K-2, and K-4 to K-14 are missing some or all of the superscripts in the title that indicate the relevant footnotes.

Table K-12 is a duplicate of Table K-11 in Volume III.

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ERRATA

Table 6-5

NUMBER OF FIELD QC SAMPLES RECEIVED AND ANALYZED BY LABORATORY

Analytical Laboratory[a]	Field QC Samples Received				Field QC Samples Analyzed			
	FHB	Split[h]	PHB	SSB	FHB	Split	PHB[f]	SSB[f]
1	14	22	8	19	14+3[d]	22+1[g]	--	--
2	12	17	7	18	12	17	--	--
3	11	14	10	19	11	14	--	--
4	12	11[b]	9	21	0	0	--	--
6	11	9	6	18	11	9	--	--
7	10	4	7	17	10	4	--	--
8	6	6	9	18	6	6	--	--
Totals	76	83	56[c]	130	67[e]	73[i]	--	--

FHB = Field handling blank
PHB = Preparation handling blank
SSB = Shipping and storage blank

[a] Laboratory 5 was not selected for study participation.

[b] One split was not sent to Laboratory 4.

[c] A total of 57 PHBs were used; however, one was unextrudable.

[d] Three of Laboratory 4's FHBs were analyzed by Laboratory 1.

[e] Nine FHBs were not analyzed by Laboratory 4.

[f] PHBs and SSBs were stored but not analyzed.

[g] A field spLit extracted by Laboratory 4 was analysed by Laboratory 1.

[h] A total of 83 pairs of splits were sent for analysis. One-half of each split was treated as a field sample and used in the statistical analysis. The other half is represented in this table.

[i] Valid results were obtained for both halves of 64 pairs of splits.

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APPENDIX O
Integrated Data Base

Soil Assessment--Indicator Chemicals

Appendix O
INTEGRATED DATA BASE
SOIL ASSESSMENT--INDICATOR CHEMICALS

An integrated data base was created using the data collected from each phase of the soil assessment for indicator chemicals. This data base is available by FOIA request. A discussion of the data and information systems used to create the data base is given in Appendix E of Volume III. This appendix provides a brief description of the data base and a data base element list so that potential users can be aware of the data available.

DESCRIPTION

The integrated data base contains 1.8 million "cells" of data and has undergone QA/QC review to identify and correct errors. The integrated data base is composed of six master files and four ancillary files:

- Field sample master file and ancillary file
- Initial calibration master file and ancillary file
- Continuing calibration master file and ancillary file
- Quality control sample master file and ancillary file
- Form I master file
- Blind quality control spike master file

The ancillary files each correspond to a master file and contain the original values for GC/MS data corrected by the analyst via the LabData Corrections subsystem.

A full user's guide will be available with the data base through FOIA request to EPA Region II.

KEY TO THE LOVE CANAL INTEGRATED DATA BASE
DATA ELEMENT LIST

Data Element ID--Identification of the form AA.Bnn, where,

AA is an abbreviation of the file:

FS = Field Sample Master File
FA = Field Sample Ancillary File
IC = Initial Calibration Master File
IA = Initial Calibration Ancillary File
CC = Continuing Calibration Master File
CA = Continuing Calibration Ancillary File
QC = Quality Control Master File
QA = Quality Control Ancillary File
F1 = Form 1 Master File
BQ = Blind Quality Control Master File

B is an alphabetical character assigned to a data element group

nn is sequentially assigned within a data element group

Name--SAS data element name

Type--type of data element:

CHAR for character, or
NUM for numeric

Length--number of bytes used to store the data element

Dimensions (for an array)--shows the number of dimensions for the data element array and the number of elements in each dimension [e.g., (8,3) is a two-dimensional array with eight rows and three columns)]

Description--text description of the data element, including "by" phrase(s) to describe any array dimensions (e.g., by 8 LCICs)

Source System--identifies the system that provided the data element values, either captured/reported or computed (marked with a "*" prefix)

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DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
****** Keys and Status ******						
FS.A01	ALANALID		CHAR	23	Analysis Lab Sample Id (Lab Id + Lab Analysis Id)	LabData
FS.A02	FSSTATUS	*	CHAR	1	Status Flag	IntDBBld
******* Inter-File Links/Secondary Keys *******						
FS.B01	ICANALID		CHAR	23	Initial Calibration Id (Lab Id + Lab Analysis Id of IC1)	LabData
FS.B02	CCANALID		CHAR	23	Continuing Calibration/Performance Check Id (Lab Id + Lab Analysis Id of CC/PC1)	LabData
FS.B03	MSANALID		CHAR	23	Matrix Spike Id (Lab Id + Lab Analysis Id)	LabData
FS.B04	MDANALID		CHAR	23	Matrix Spike Duplicate Id (Lab Id + Lab Analysis Id)	LabData
FS.B05	MBANALID		CHAR	23	Lab Method Blank Id (Lab Id + Lab Analysis Id)	LabData
FS.B06	RBANALID		CHAR	23	Reagent Blank Id (Lab Id + Lab Analysis Id)	LabData
FS.B07	QCANALID		CHAR	23	Quality Control Id (Lab Id + Lab Analysis Id)	not currently used
FS.B08	CLEANHS		CHAR	8	Original Project Id (HS Number)	IntDBBld
******* Intra-File Links/Secondary Keys *******						
FS.C01	HSID		CHAR	6	Project Field Sample Id (HS #)	SampTrac
FS.C02	FDUPID		CHAR	6	Revised Site Id (of the form nnnn or nnnnR); if no R suffix, resampling not done	SampTrac
FS.C03	FHBID		CHAR	6	Field Handling Blank Id (HS #)	SampTrac
FS.C04	SSBIDF		CHAR	6	Field Group Ship/Store Blank Id (HS #)	SampTrac
FS.C05	SSBIDP		CHAR	6	Prep Group Ship/Store Blank Id (HS #)	SampTrac
FS.C06	PHBID		CHAR	6	Prep Lab Handling Blank Id (HS #)	SampTrac
FS.C07	PLSID		CHAR	6	Prep Lab Split Id (HS #)	SampTrac
******* Chronology *******						
FS.D01	FSFCDTE		NUM	8	Field Collection Date	SampTrac
FS.D02	FSFCTME		NUM	8	Field Collection Time	SampTrac
FS.D03	FSFSDTE		NUM	8	Field Ship Date	SampTrac
FS.D04	FSPLDTE		NUM	8	Prep Lab Login Date	SampTrac
FS.D05	FSPMDTE		NUM	8	Prep Lab Mix Date	SampTrac
FS.D06	FSPMTME		NUM	8	Prep Lab Mix Time	SampTrac
FS.D07	FSPSDTE		NUM	8	Prep Lab Ship Date	SampTrac
FS.D08	FSALDTES		NUM	8	Analysis Lab Login Date (Sample Tracking)	SampTrac
FS.D09	FSALDTEL		NUM	8	Analysis Lab Login Date (LabData)	LabData
FS.D10	FSAEDTE		NUM	8	Analysis Lab Extract Date	LabData
FS.D11	FSAADTE		NUM	8	Analysis Lab Analysis Date	LabData
FS.D12	FSAATME		NUM	8	Analysis Lab Analysis Time	LabData
FS.D13	FSDBDTE		NUM	8	Data Validation Date	DataVal
******* Data Transfer Tracking *******						
FS.E01	FSGENDTE		NUM	8	LabData Gen Date	LabData
FS.E02	FSGENTME		NUM	8	LabData Gen Time	LabData
FS.E03	FSADDDTE		NUM	8	DB Add Date	IntDBBld
FS.E04	FSADDTME		NUM	8	DB Add Time	IntDBBld
FS.E05	FSUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
FS.E06	FSUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
FS.E07	FSUPDCNT		NUM	8	DB Update Count	IntDBBld

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Field Sampling Data **						
FS.F01	COLFORM		CHAR	5	Sample Collection Form #	SampTrac
FS.F02	COLFORMR		CHAR	5	Sample Collection Replacement Form #	SampTrac
FS.F03	SAMPTYPE		CHAR	6	Sample Type	SampTrac
FS.F04	SITENBR		CHAR	4	Site Number	SampTrac
FS.F05	STREET		CHAR	70	Street Address	SampTrac
FS.F06	MEDIA		CHAR	1	Media (a constant of 'S')	SampTrac
FS.F07	XCOORD		NUM	8	Site X Coordinate	SampTrac
FS.F08	YCOORD		NUM	8	Site Y Coordinate	SampTrac
FS.F09	XACTUAL		NUM	8	Site X Coordinate	SampTrac
FS.F10	YACTUAL		NUM	8	Site Y Coordinate	SampTrac
FS.F11	LOCDIFF		NUM	8	Difference in feet between X/YCOORD & X/YACTUAL	SampTrac
FS.F12	AREAID		CHAR	1	Area Id	IntDBBld
FS.F13	NEIGHID		CHAR	2	Neighborhood Id	SampTrac
FS.F14	TEAMNBR		CHAR	2	Sampling Team Number	SampTrac
FS.F15	COLLECTR		CHAR	20	Sample Collector Name (text)	SampTrac
FS.F16	SOILCOMP		CHAR	80	Soil Composition	SampTrac
FS.F17	TUBENBR		CHAR	4	Collection Tube Number	SampTrac
FS.F18	COLMLEN		NUM	8	Length of Soil Column	SampTrac
FS.F19	DUPLICAT		CHAR	1	Duplicate Flag	currently not used
FS.F20	FLDCOM	(3)	CHAR	80	Field Comments (text 3X80)	SampTrac
FS.F21	FCOCFORM		CHAR	4	Field Chain of Custody Form # (of the form Fnnn)	SampTrac
FS.F22	FTRFFORM		CHAR	4	Traffic Report for Tubes Form # (of the form nnnn)	SampTrac
FS.F23	FLFEDEX		CHAR	10	Fed Ex Airbill Number	SampTrac
FS.F24	FLSRMKS		CHAR	80	Field Shipping Special Instructions	SampTrac
					Field QC Samples Only Data	
FS.F25	FLPRVBLK		CHAR	6	Previous Field Blank Id (HS #)	currently not used
******* Preparation Lab Data **						
FS.G01	PREPLAB		CHAR	3	Prep Lab Id (a constant of 'CAA')	SampTrac
FS.G02	PREPCOND		CHAR	30	Condition on Receipt by Prep Lab (text)	SampTrac
FS.G03	PREPCOMM		CHAR	12	Sampling Team Comment	SampTrac
FS.G04	PLRECBY		CHAR	20	Person Receiving in Prep Lab	SampTrac
FS.G05	SPFORM		CHAR	5	Sample Preparation Form # (of the form Cnnnn)	SampTrac
FS.G06	MIXRNAME		CHAR	20	Mixer Name (text)	SampTrac
FS.G07	MIXTEAM		CHAR	1	Mixing Team	SampTrac
FS.G08	PREPCOM	(2)	CHAR	80	Prep Comments (text 2X80)	SampTrac
FS.G09	TRAKCOM		CHAR	19	Tracking Comment	SampTrac
FS.G10	SPLIT		CHAR	1	Designated Split	SampTrac
FS.G11	PCOCFORM		CHAR	5	Prep Lab Chain of Custody Form # (of the form 'Ennn ')	SampTrac
FS.G12	PTRFFORM		CHAR	5	Traffic Report for Prepared Samples Form # (of the form 'Dnnn ')	SampTrac
FS.G13	MSFLAG		CHAR	1	Matrix Spike Flag	currently not used
FS.G14	PLJARNBR		NUM	8	Preparation Lab Jar Number	SampTrac
FS.G15	PLSPACE		NUM	8	Head Space	SampTrac
FS.G16	PLPOSHI		CHAR	1	Possible High Analysis Values	SampTrac
FS.G17	PLSHMETH		CHAR	7	Preparation Lab Shipping Method (a constant of 'FED EX')	SampTrac

LOVE CANAL HABITABILITY STUDY

DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
FS.G18	PLFEDEX		CHAR	10	Fed Ex Airbill Number	SampTrac
FS.G19	PLSRMKS		CHAR	80	Prep Lab Special Shipping Instructions Prep Lab QC Samples Only	SampTrac
FS.G20	PLPRVBLK		CHAR	6	Previous Prep Lab Blank Id (HS #)	currently not used
FS.G21	EXCPFLAG		NUM	8	Exception Flag	SampTrac
FS.G22	FTTEMP		NUM	8	Temperature inside cooler on arrival at preparation lab, in degrees Celsuis	SampTrac
FS.G23	TRTEMP		NUM	8	Temperature inside cooler on arrival at analytic lab, in degrees Celsuis	SampTrac

******* Analysis Lab Sample Login Data **

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
FS.H01	FSSMPL		CHAR	10	Project Sample Id	LabData
FS.H02	FSALID		CHAR	3	Analytic Laboratory Id	SampTrac
FS.H03	FSALCOND		CHAR	30	Condition on Receipt by Analysis Lab (text)	SampTrac
FS.H04	ALRECBY		CHAR	20	Person Receiving in Analysis Lab	SampTrac
FS.H05	FSRERUN		CHAR	2	Re-run Flag	currently not used
FS.H06	FSRRSTAT		CHAR	1	Re-run Type	currently not used
FS.H07	FSORIG		CHAR	1	Orig. Found Flag	currently not used

******* Analysis Lab Sample Extraction Data ***

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
FS.I01	FSTWTEXT		NUM	8	Target Weight to Extract (gm)	LabData
FS.I02	FSWTEXT		NUM	8	Weight Extracted (gm)	LabData
FS.I03	FSMOIST		NUM	8	Percent Moisture	LabData
FS.I04	FSCONCDF		NUM	8	Concentration Dilution Factor	LabData
FS.I05	FSEXTANL		CHAR	8	Extraction Analyst	LabData

******* Analysis Lab Injection Data ***

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
FS.J01	FSINSTID		CHAR	15	GC/MS Instrument Id	LabData
FS.J02	FSANLST		CHAR	8	GC/MS Analyst	LabData
FS.J03	FSFILE		CHAR	15	GC/MS Datafile Id	LabData
FS.J04	FSINJVOL		NUM	8	Injection Volume (ul)	LabData

******* Analysis Lab Interpretation Data **

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
FS.K01	FSQFILE		CHAR	12	GC/MS Shift Results File Name	LabData
FS.K02	FSQMTH	(8,3)	CHAR	1	Quantitation Method Flag, by 8 LCICs, by 3 Ions	LabData
FS.K03	FSQION	(8)	CHAR	1	LCIC Quantitation Ion Selection, by 8 LCICs	LabData
FS.K04	FSLCPH	(8,3)	NUM	8	Peak Height, by 8 LCICs, by 3 Ions	LabData
FS.K05	FSISPH	(5)	NUM	8	Peak Height, by 5 Int. Stds. (Primary Ion)	LabData
FS.K06	FSPYRPH		NUM	8	Peak Height Pyrene-D10 (Secondary Ion)	LabData
FS.K07	FSSSPH	(3)	NUM	8	Peak Height, by 3 Surrogates (Primary Ion)	LabData
FS.K08	FSHLCS	(8,3)	NUM	8	Scan for Peak Height, by 8 LCICs, by 3 Ions	LabData
FS.K09	FSHLCR	(8,3)	NUM	8	Retention Time for Peak Height, by 8 LCICs, by 3 Ions	LabData
FS.K10	FSHISS	(5)	NUM	8	Scan for Peak Height, by 5 Int. Stds.	LabData
FS.K11	FSHISR	(5)	NUM	8	Retention Time for Peak Height, by 5 Int. Stds.	LabData
FS.K12	FSHPYRS		NUM	8	Scan for Peak Height for Pyrene-D10	LabData
FS.K13	FSHPYRR		NUM	8	Retention Time for Peak Height for Pyrene-D10	LabData
FS.K14	FSHSSS	(3)	NUM	8	Scan for Peak Height, by 3 Surrogates	LabData
FS.K15	FSHSSR	(3)	NUM	8	Retention Time for Peak Height, by 3 Surrogates	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Correction Flags **						
FS.L01	FSCDATE		CHAR	1	Analysis Lab Analysis Date	LabData
FS.L02	FSCTIME		CHAR	1	Analysis Lab Analysis Time	LabData
FS.L03	FSCANAL		CHAR	1	Analyst Entering the Correction Data	LabData
FS.L04	FSCLCA	(8,3)	CHAR	1	Area, by 8 LCICs, by 3 Ions	LabData
FS.L05	FSCLCS	(8,3)	CHAR	1	Scan, by 8 LCICs, by 3 Ions	LabData
FS.L06	FSCLCR	(8,3)	CHAR	1	Retention Time, by 8 LCICs, by 3 Ions	LabData
FS.L07	FSCISA	(5)	CHAR	1	Area, by 5 Int. Stds. (Primary Ion)	LabData
FS.L08	FSCISS	(5)	CHAR	1	Scan, by 5 Int. Stds. (Primary Ion)	LabData
FS.L09	FSCISR	(5)	CHAR	1	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
FS.L10	FSCPYRA		CHAR	1	Area Pyrene-D10 (Secondary Ion)	LabData
FS.L11	FSCPYRS		CHAR	1	Scan Pyrene-D10 (Secondary Ion)	LabData
FS.L12	FSCPYRR		CHAR	1	Retention Time Pyrene-D10 (Secondary Ion)	LabData
FS.L13	FSCSSA	(3)	CHAR	1	Area, by 3 Surrogates (Primary Ion)	LabData
FS.L14	FSCSSS	(3)	CHAR	1	Scan, by 3 Surrogates (Primary Ion)	LabData
FS.L15	FSCSSR	(3)	CHAR	1	Retention Time, by 3 Surrogates (Primary Ion)	LabData
******* Analysis Raw Data (After Corrections, if any) **						
FS.M01	FSLCA	(8,3)	NUM	8	Area, by 8 LCICs, by 3 Ions	LabData
FS.M02	FSLCS	(8,3)	NUM	8	Scan, by 8 LCICs, by 3 Ions	LabData
FS.M03	FSLCR	(8,3)	NUM	8	Retention Time, by 8 LCICs, by 3 Ions	LabData
FS.M04	FSISA	(5)	NUM	8	Area, by 5 Int. Stds. (Primary Ion)	LabData
FS.M05	FSPYRA		NUM	8	Area Pyrene-D10 (Secondary Ion)	LabData
FS.M06	FSISS	(5)	NUM	8	Scan, by 5 Int. Stds. (Primary Ion)	LabData
FS.M07	FSPYRS		NUM	8	Scan Pyrene-D10 (Secondary Ion)	LabData
FS.M08	FSISR	(5)	NUM	8	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
FS.M09	FSPYRR		NUM	8	Retention Time Pyrene-D10 (Secondary Ion)	LabData
FS.M10	FSSSA	(3)	NUM	8	Area, by 3 Surrogates (Primary Ion)	LabData
FS.M11	FSSSS	(3)	NUM	8	Scan, by 3 Surrogates (Primary Ion)	LabData
FS.M12	FSSSR	(3)	NUM	8	Retention Time, by 3 Surrogates (Primary Ion)	LabData
******* LabData Computations for Field and QC Samples **						
FS.N01	FSRR	(8)	NUM	8	Relative Retention Time, by 8 LCICs (Quantitation Ion)	*LabData
FS.N02	FSRRC	(8)	NUM	8	Relative Retention Time Criteria, by 8 LCICs	LabData
FS.N03	FSRRF	(8)	CHAR	1	Flag for Rel. Ret. Time Out of Criteria, by 8 LCICs	*LabData
FS.N04	FSCONCB	(8)	NUM	8	PreID-criteria Concentration, by 8 LCICs (i.e. primary ion equivalent concentration)	*LabData
FS.N05	FSCONCA	(8)	NUM	8	Id Criteria applied Concentration, by 8 LCICs	*LabData
FS.N06	FSIRAT	(8)	NUM	8	Ion Ratio, by 8 LCICs	*LabData
FS.N07	FSIONF	(8)	CHAR	1	Flag for All Ions Being Present, by 8 LCICs	*LabData
FS.N08	FSMINS	(8)	NUM	8	Minimum Scan Number of 3 Ions, by 8 LCICs	LabData
FS.N09	FSMAXS	(8)	NUM	8	Maximum Scan Number of 3 Ions, by 8 LCICs	LabData
FS.N10	FSRANG	(8)	NUM	8	Scan Range (Max - Min), by 8 LCICs	*LabData
FS.N11	FSRANGF	(8)	CHAR	1	Flag for Scan range >1, by 8 LCICs	*LabData
FS.N12	FSIDEVT	(8)	NUM	8	Ion Ratio % Dev. from Theoretical Values, by 8 LCICs	*LabData
FS.N13	FSIDEVF	(8)	CHAR	1	Flag for Ion ratio % Dev. Out of Criteria, by 8 LCICs	*LabData
FS.N14	FSPRESCR		CHAR	3	Flag for Analysis Pre-screen	LabData

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DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
FS.N15	FSSULFUR		CHAR	1	Flag for Sulphur Cleanup Performed	LabData
******* LabData Computations for Surrogate Standards ***						
FS.O01	FSPR	(3)	NUM	8	% Recovery by 3 Surrogates	*LabData
FS.O02	FSPRF	(3)	CHAR	1	Flag for % Rec. Out of Criteria, by 3 Surrogates	*LabData
FS.O03	FSSSADD	(3)	NUM	8	Amount of added(ng), by 3 Surrogates	LabData
FS.O04	FSPRCL	(3)	NUM	8	% Recovery Criteria lower limit, by 3 Surrogates	LabData
FS.O05	FSPRCU	(3)	NUM	8	% Recovery Criteria upper limit, by 3 Surrogates	LabData
FS.O06	FSPROUT		NUM	8	Number of % Rec. Out of Criteria	LabData
******* LabData Computations for Internal Standards ***						
FS.P01	FSISADD		NUM	8	Internal Standard Quantity Added (in nanograms)	LabData
FS.P02	FSRD	(5)	NUM	8	Ret. Time Difference From CC Val, by 5 Int Stds	*LabData
FS.P03	FSAD	(5)	NUM	8	Area Difference % From CC Val, by 5 Int Stds	*LabData
FS.P04	FSRF	(5)	CHAR	1	Flag for Ret. Time Out of Criteria, by 5 Int Stds	*LabData
FS.P05	FSAF	(5)	CHAR	1	Flag for Area Out of Criteria, by 5 Int Stds	*LabData
FS.P06	FSRDC	(5)	NUM	8	Retention Time Difference Criteria, by 5 Int Stds	LabData
FS.P07	FSADCL	(5)	NUM	8	Area % Diff. Crit. lower limit, by 5 Int Stds	LabData
FS.P08	FSADCU	(5)	NUM	8	Area % Diff. Crit. upper limit, by 5 Int Stds	LabData
******* Data Validation Flags and Comments **						
FS.Q01	FSSURRA		CHAR	1	Check surrogates spiked in all samples	DataVal
FS.Q02	FSSURRB		CHAR	1	Surrogates recoveries within criteria	DataVal
FS.Q03	FSSURRC		CHAR	1	Surrogates Miscellaneous	DataVal
FS.Q04	FSSURCM	(3)	CHAR	60	Surrogates Comments	DataVal
FS.Q05	FSINTA		CHAR	1	Internal Standards RT Criteria	DataVal
FS.Q06	FSINTB		CHAR	1	Internal Standards Area Criteria	DataVal
FS.Q07	FSINTC		CHAR	2	Internal Standards Miscellaneous	DataVal
FS.Q08	FSINTCM	(3)	CHAR	60	Internal Standards Comments	DataVal
FS.Q09	FSIDA		CHAR	1	Id All ions maximize simultaneously	DataVal
FS.Q10	FSIDB		CHAR	1	Id Appropriate flags used.	DataVal
FS.Q11	FSIDC		CHAR	1	Id All peaks reported that meet id criteria	DataVal
FS.Q12	FSIDD		CHAR	2	Id Low level peaks examined	DataVal
FS.Q13	FSIDE		NUM	2	Id Miscellaneous	DataVal
FS.Q14	FSIDCOM	(3)	CHAR	60	Id Comments	DataVal
FS.Q15	FSQTA		CHAR	1	Quantitation appropriate RRF's used if nonstandard	DataVal
FS.Q16	FSQTB		CHAR	1	Check integration parameters if manual quant. used	DataVal
FS.Q17	FSQTC		CHAR	2	Quantitation Miscellaneous	DataVal
FS.Q18	FSQTCOM	(3)	CHAR	60	Quantitation Comments	DataVal
FS.Q19	FSGENA		CHAR	2	Review case narrative and address all problems	DataVal
FS.Q20	FSGENB		CHAR	2	Examine SICPS	DataVal
FS.Q21	FSGENC		CHAR	2	Examine quantitation reports	DataVal
FS.Q22	FSGEND		CHAR	2	General Miscellaneous	DataVal
FS.Q23	FSGENCM	(3)	CHAR	60	General Comments	DataVal
FS.Q24	FSDQ	(8,5)	CHAR	2	Data Qualifier flags samples by analyte	DataVal
******* Integrated DB Audit System Flags **						
FS.R01	FSTRACK		CHAR	1	Flag for Sample NOT Found in Sample Tracking	IntDBBld

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
FS.R02	FSF1FLAG		CHAR	1	Flag for Sample Match to FORM1 Master File	IntDBBld
FS.R03	FSICREF		CHAR	1	Flag for IC not found or date/time inconsistent	IntDBBld
FS.R04	FSCCREF		CHAR	1	Flag for CC not found or date/time inconsistent	IntDBBld
FS.R05	FSMSREF		CHAR	1	Flag for MS not found	IntDBBld
FS.R06	FSMDREF		CHAR	1	Flag for MSD not found	IntDBBld
FS.R07	FSRBREF		CHAR	1	Flag for RB not found	IntDBBld
FS.R08	FSMBREF		CHAR	1	Flag for MB not found	IntDBBld
FS.R09	FSDUP		CHAR	1	Flag for Field Duplicate not found	currently not used
FS.R10	FSFHB		CHAR	1	Flag for Field Handling Blank not found	currently not used
FS.R11	FSSSBF		CHAR	1	Flag for Shipping & Storage Blank not found	currently not used
FS.R12	FSSSBP		CHAR	1	Flag for Shipping & Storage Blank not found	currently not used
FS.R13	FSPHB		CHAR	1	Flag for Prep Lab Handling Blank not found	currently not used
FS.R14	FSPLS		CHAR	1	Flag for Prep Lab Split not found	currently not used
FS.R15	FSRECALC		CHAR	1	Flag for recalculation descrepancy on at least one data element computed by LabData system (within .2% tolerance)	IntDBBld
FS.R16	FSDIFLAB		CHAR	1	Flag for diff. lab between LabData & Samptrac	currently not used

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
****** Keys **						
FA.A01	ALANALID		CHAR	23	Analysis Lab Sample Id (Lab Id + Lab Analysis Id)	LabData
******* Data Transfer Tracking **						
FA.B01	FSGENDTE		NUM	8	LabData Gen Date	LabData
FA.B02	FSGENTME		NUM	8	LabData Gen Time	LabData
FA.B03	FSADDDTE		NUM	8	DB Add Date	IntDBBld
FA.B04	FSADDTME		NUM	8	DB Add Time	IntDBBld
FA.B05	FSUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
FA.B06	FSUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
FA.B07	FSUPDCNT		NUM	8	DB Update Count	IntDBBld
******* Data Replaced by Corrections **						
FA.M01	FSLCA	(8,3)	NUM	8	Area, by 8 LCICs, by 3 Ions	LabData
FA.M02	FSLCS	(8,3)	NUM	8	Scan, by 8 LCICs, by 3 Ions	LabData
FA.M03	FSLCR	(8,3)	NUM	8	Retention Time, by 8 LCICs, by 3 Ions	LabData
FA.M04	FSISA	(5)	NUM	8	Area, by 5 Int. Stds. (Primary Ion)	LabData
FA.C05	FSPYRA		NUM	8	Area Pyrene-D10 (Secondary Ion)	LabData
FA.C06	FSISS	(5)	NUM	8	Scan, by 5 Int. Stds. (Primary Ion)	LabData
FA.C07	FSPYRS		NUM	8	Scan Pyrene-D10 (Secondary Ion)	LabData
FA.C08	FSISR	(5)	NUM	8	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
FA.C09	FSPYRR		NUM	8	Retention Time Pyrene-D10 (Secondary Ion)	LabData
FA.C10	FSSSA	(3)	NUM	8	Area, by 3 Surrogates (Primary Ion)	LabData
FA.C11	FSSSS	(3)	NUM	8	Scan, by 3 Surrogates (Primary Ion)	LabData
FA.C12	FSSSR	(3)	NUM	8	Retention Time, by 3 Surrogates (Primary Ion)	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
***** Keys and Status **						
IC.A01	ICANALID		CHAR	23	Initial Calibration Id (Lab Id + Lab Analysis Id of the IC1 analysis)	LabData
IC.A02	ICANAL	(4)	CHAR	23	Initial Calibration Id (Lab Id + Lab Analysis Id of the IC2-IC5 analyses)	LabData
IC.A03	ICSTATUS		CHAR	1	Status Flag	IntDBBld
******* Chronology **						
IC.B01	ICAADTE	(6)	NUM	8	Analysis Lab Analysis Date, by 5 Calibration Concentrations and EMSL PC	LabData
IC.B02	ICAATME	(6)	NUM	8	Analysis Lab Analysis Time by 5 Calibration Concentrations and EMSL PC	LabData
******* Data Transfer Tracking **						
IC.C01	ICGENDTE		NUM	8	LabData Gen Date	LabData
IC.C02	ICGENTME		NUM	8	LabData Gen Time	LabData
IC.C03	ICADDDTE		NUM	8	DB Add Date	IntDBBld
IC.C04	ICADDTME		NUM	8	DB Add Time	IntDBBld
IC.C05	ICUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
IC.C06	ICUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
IC.C07	ICUPDCNT		NUM	8	DB Update Count	IntDBBld
******* Analysis Lab Sample Login Data **						
IC.D01	ICSMPL	(6)	CHAR	10	Project Sample Id for IC1 thru IC5 and EMSL PC	LabData
IC.D02	ICALID		CHAR	3	Analytic Laboratory Id	LabData
******* Analysis Lab Injection Data **						
IC.E01	ICINSTID		CHAR	15	GC/MS Instrument Id	LabData
IC.E02	ICINSTMF		CHAR	20	GC/MS Instrument Manufacturer	LabData
IC.E03	ICINSTMN		CHAR	20	GC/MS Instrument Model Number	LabData
IC.E04	ICISCODE		CHAR	1	Internal Standard Solution Code	LabData
IC.E05	ICSOLCD	(5)	CHAR	1	Initial Calibration Solution Codes (5)	LabData
IC.E06	ICCCCODE		CHAR	1	Continuing Calibration Solution Code	LabData
IC.E07	ICCOLMMF		CHAR	20	Column Manufacturer	LabData
IC.E08	ICCOLMSN		CHAR	20	Column Serial Number	LabData
IC.E09	ICANLST	(6)	CHAR	8	Analyst, by 5 Calibration Concentrations and EMSL PC	LabData
IC.E10	ICFILE	(6)	CHAR	15	Datafile Id, by 5 Calibration Concentrations and EMSL PC	LabData
IC.E11	ICINJVL	(6)	NUM	8	Injection Volume (ul), by 5 Calibration Concentrations and EMSL PC	LabData
******* Analysis Lab Interpretation Data **						
IC.F01	ICQFILE		CHAR	12	GC/MS Shift Results File Name For IC2 ONLY:	LabData
IC.F02	ICQMTH	(8,3)	CHAR	1	Quantitation Method Flag, by 8 LCICs, by 3 Ions	LabData
IC.F03	ICQION	(8)	CHAR	1	LCIC Quantitation Ion Selection, by 8 LCICs	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
IC.F04	ICLCPH	(8,3)	NUM	8	Peak Height, by 8 LCICs, by 3 Ions	LabData
IC.F05	ICISPH	(5)	NUM	8	Peak Height, by 5 Int. Stds. (Primary Ion)	LabData
IC.F06	ICPYRPH		NUM	8	Peak Height Pyrene-D10 (Secondary Ion)	LabData
IC.F07	ICSSPH	(3)	NUM	8	Peak Height, by 3 Surrogates (Primary Ion)	LabData
IC.F08	ICHLCS	(8,3)	NUM	8	Scan for Peak Height, by 8 LCICs, by 3 Ions	LabData
IC.F09	ICHLCR	(8,3)	NUM	8	Retention Time for Peak Height, by 8 LCICs, by 3 Ions	LabData
IC.F10	ICHISS	(5)	NUM	8	Scan for Peak Height, by 5 Int. Stds.	LabData
IC.F11	ICHISR	(5)	NUM	8	Retention Time for Peak Height, by 5 Int. Stds.	LabData
IC.F12	ICHPYRS		NUM	8	Scan for Peak Height for Pyrene-D10	LabData
IC.F13	ICHPYRR		NUM	8	Retention Time for Peak Height for Pyrene-D10	LabData
IC.F14	ICHSSS	(3)	NUM	8	Scan for Peak Height, by 3 Surrogates	LabData
IC.F15	ICHSSR	(3)	NUM	8	Retention Time for Peak Height, by 3 Surrogates	LabData

******* Correction Flags (For IC2 ONLY) ***

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
IC.G01	ICCDATE		CHAR	1	Analysis Lab Analysis Date	LabData
IC.G02	ICCTIME		CHAR	1	Analysis Lab Analysis Time	LabData
IC.G03	ICCANAL		CHAR	1	Analyst	LabData
IC.G04	ICCLCA	(8,3)	CHAR	1	Area, by 8 LCICs, by 3 Ions	LabData
IC.G05	ICCLCS	(8,3)	CHAR	1	Scan, by 8 LCICs, by 3 Ions	LabData
IC.G06	ICCLCR	(8,3)	CHAR	1	Retention Time, by 8 LCICs, by 3 Ions	LabData
IC.G07	ICCISA	(5)	CHAR	1	Area, by 5 Int. Stds. (Primary Ion)	LabData
IC.G08	ICCISS	(5)	CHAR	1	Scan, by 5 Int. Stds. (Primary Ion)	LabData
IC.G09	ICCISR	(5)	CHAR	1	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
IC.G10	ICCPYRA		CHAR	1	Area Pyrene-D10 (Secondary Ion)	LabData
IC.G11	ICCPYRS		CHAR	1	Scan Pyrene-D10 (Secondary Ion)	LabData
IC.G12	ICCPYRR		CHAR	1	Retention Time Pyrene-D10 (Secondary Ion)	LabData
IC.G13	ICCSSA	(3)	CHAR	1	Area, by 3 Surrogates (Primary Ion)	LabData
IC.G14	ICCSSS	(3)	CHAR	1	Scan, by 3 Surrogates (Primary Ion)	LabData
IC.G15	ICCSSR	(3)	CHAR	1	Retention Time, by 3 Surrogates (Primary Ion)	LabData

******* Analysis Raw Data, By 5 Calibration Concentrations and EMSL Performance Check*************************
(After Corrections, if any)

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
IC.H01	ICLCA	(6,8,3)	NUM	8	Area, by 8 LCICs, by 3 Ions	LabData
IC.H02	ICLCS	(6,8,3)	NUM	8	Scan, by 8 LCICs, by 3 Ions	LabData
IC.H03	ICLCR	(6,8,3)	NUM	8	Retention Time, by 8 LCICs, by 3 Ions	LabData
IC.H04	ICISA	(6,5)	NUM	8	Area, by 5 Int. Stds. (Primary Ion)	LabData
IC.H05	ICPYRA	(6)	NUM	8	Area Pyrene-D10 (Secondary Ion)	LabData
IC.H06	ICISS	(6,5)	NUM	8	Scan, by 5 Int. Stds. (Primary Ion)	LabData
IC.H07	ICPYRS	(6)	NUM	8	Scan Pyrene-D10 (Secondary Ion)	LabData
IC.H08	ICISR	(6,5)	NUM	8	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
IC.H09	ICPYRR	(6)	NUM	8	Retention Time Pyrene-D10 (Secondary Ion)	LabData
IC.H10	ICSSA	(6,3)	NUM	8	Area, by 3 Surrogates (Primary Ion)	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
IC.H11	ICSSS	(6,3)	NUM	8	Scan, by 3 Surrogates (Primary Ion)	LabData
IC.H12	ICSSR	(6,3)	NUM	8	Retention Time, by 3 Surrogates (Primary Ion)	LabData
******* LabData Computations for Initial Calibration**						
IC.I01	ICMRF	(11)	NUM	8	Mean Response Factors, by 8 LCICs and 3 Surrogates	*LabData
IC.I02	ICRSD	(11)	NUM	8	% Relative Std. Dev., by 8 LCICs and 3 Surrogates	*LabData
IC.I03	ICRSDC	(11)	NUM	8	% Relative Std. Dev. criteria, by 8 LCICs and 3 Surrogates	LabData
IC.I04	ICRSDF	(11)	CHAR	1	Flag for % Relative Std. Dev. out of criteria, by 8 LCICs and 3 Surrogates	*LabData
IC.I05	ICRSDOUT		NUM	8	Number of % Relative Std. Dev. out of criteria	LabData
IC.I06	ICRF	(11,5)	NUM	8	Response Factors, by 8 LCICs and 3 surrogates, by 5 Calibration Concentrations	*LabData
IC.I07	ICCONC	(5)	NUM	8	Concentrations, by 5 Calibration Concentrations	LabData
******* LabData Computations for EMSL Performance Check **						
IC.J01	PCTCON	(11)	NUM	8	Theoretical Concentrations, by 8 LCICs and 3 Surrogates	LabData
IC.J02	PCPRLC	(11)	NUM	8	% Recovery Lower Criteria, by 8 LCICs and 3 Surrogates	LabData
IC.J03	PCPRUC	(11)	NUM	8	% Recovery Upper Criteria, by 8 LCICs and 3 Surrogates	LabData
IC.J04	PCPROUT		NUM	8	Number of % Recovery Out of Criteria	LabData
IC.J05	PCCONC	(11)	NUM	8	Concentrations, by 8 LCICs and 3 Surrogates	*LabData
IC.J06	PCPR	(11)	NUM	8	% Recovery, by 8 LCICs and 3 Surrogates	*LabData
IC.J07	PCPRF	(11)	CHAR	1	Flag for % Recovery Within Criteria, by 8 LCICs and 3 Surrogates	*LabData
IC.J08	PCISADD		NUM	8	Amount of Internal Standard Added	LabData
IC.J09	PCVOLMCS		NUM	8	Volume of Check Standard Solution	LabData
******* Data Validation Flags and Comments **						
IC.K01	ICCALA		CHAR	1	IC % RSD exceptions checked	DataVal
IC.K02	ICCALB		CHAR	2	IC check quantitation reports for evidence of editing	DataVal
IC.K03	ICCALC		CHAR	2	IC examine chromatograms	DataVal
IC.K04	ICCALD		CHAR	2	IC Miscellaneous	DataVal
IC.K05	ICDVCOM	(3)	CHAR	60	IC Comments	DataVal
******* Integrated DB Audit System Results **						
IC.L01	ICRECALC		CHAR	1	Flag for calculation descrepancies	IntDBBld

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
***** Keys **						
IA.A01	ICANALID		CHAR	23	Initial Calibration Id (Lab Id + Lab Analysis Id of the IC1 analysis)	LabData
******* Data Transfer Tracking ***						
IA.B01	ICGENDTE		NUM	8	LabData Gen Date	LabData
IA.B02	ICGENTME		NUM	8	LabData Gen Time	LabData
IA.B03	ICADDDTE		NUM	8	DB Add Date	IntDBBld
IA.B04	ICADDTME		NUM	8	DB Add Time	IntDBBld
IA.B05	ICUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
IA.B06	ICUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
IA.B07	ICUPDCNT		NUM	8	DB Update Count	IntDBBld
******* Data Replaced by Corrections **						
IA.C01	ICLCA	(6,8,3)	NUM	8	Area, by 8 LCICs, by 3 Ions	LabData
IA.C02	ICLCS	(6,8,3)	NUM	8	Scan, by 8 LCICs, by 3 Ions	LabData
IA.C03	ICLCR	(6,8,3)	NUM	8	Retention Time, by 8 LCICs, by 3 Ions	LabData
IA.C04	ICISA	(6,5)	NUM	8	Area, by 5 Int. Stds. (Primary Ion)	LabData
IA.C05	ICPYRA	(6)	NUM	8	Area Pyrene-D10 (Secondary Ion)	LabData
IA.C06	ICISS	(6,5)	NUM	8	Scan, by 5 Int. Stds. (Primary Ion)	LabData
IA.C07	ICPYRS	(6)	NUM	8	Scan Pyrene-D10 (Secondary Ion)	LabData
IA.C08	ICISR	(6,5)	NUM	8	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
IA.C09	ICPYRR	(6)	NUM	8	Retention Time Pyrene-D10 (Secondary Ion)	LabData
IA.C10	ICSSA	(6,3)	NUM	8	Area, by 3 Surrogates (Primary Ion)	LabData
IA.C11	ICSSS	(6,3)	NUM	8	Scan, by 3 Surrogates (Primary Ion)	LabData
IA.C12	ICSSR	(6,3)	NUM	8	Retention Time, by 3 Surrogates (Primary Ion)	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Keys and Status ***						
CC.A01	CCANALID		CHAR	23	Continuing Calibration/Performance Check 1 Id (Lab Id + Lab Analysis Id of CC/PC1)	LabData
CC.A02	CCPC2ID		CHAR	23	Performance Check 2 Id (Lab Id + Lab Analysis Id of PC2)	LabData
CC.A03	CCSTATUS		CHAR	1	Status Flag	LabData
******* Chronology ***						
CC.B01	CCAADTE		NUM	8	CC/PC1 Analysis Lab Analysis Date	LabData
CC.B02	CCAATME		NUM	8	CC/PC1 Analysis Lab Analysis Time	LabData
CC.B03	PC2AADTE		NUM	8	PC2 Analysis Lab Analysis Date	LabData
CC.B04	PC2AATME		NUM	8	PC2 Analysis Lab Analysis Time	LabData
******* Data Transfer Tracking ***						
CC.C01	CCGENDTE		NUM	8	LabData Gen Date	LabData
CC.C02	CCGENTME		NUM	8	LabData Gen Time	LabData
CC.C03	CCADDDTE		NUM	8	DB Add Date	IntDBBld
CC.C04	CCADDTME		NUM	8	DB Add Time	IntDBBld
CC.C05	CCUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
CC.C06	CCUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
CC.C07	CCUPDCNT		NUM	8	DB Update Count	IntDBBld
******* Analysis Lab Sample Login Data ***						
CC.D01	CCSMPL	(2)	CHAR	10	Sample Id for CC/PC1 and PC2	LabData
CC.D02	CCALID		CHAR	3	Analysis Lab Id	LabData
******* Analysis Lab Injection Data (For CC/PC1 and PC2) ***						
CC.E01	CCINSTID		CHAR	15	GC/MS Instrument Id	LabData
CC.E02	CCANLST	(2)	CHAR	8	GC/MS Analyst, by 2 Analyses	LabData
CC.E03	CCFILE	(2)	CHAR	15	GC/MS Datafile Id, by 2 Analyses	LabData
CC.E04	CCINJVL	(2)	NUM	8	Injection Volume (ul), by 2 Analyses	LabData
******* Analysis Lab Interpretation Data ***						
CC.F01	CCQFILE		CHAR	12	GC/MS Shift Results File Name For CC/PC1 ONLY:	LabData
CC.F02	CCQMTH	(8,3)	CHAR	1	Quantitation Method Flag, by 8 LCICs, by 3 Ions	LabData
CC.F03	CCQION	(8)	CHAR	1	LCIC Quantitation Ion Selection, By 8 LCICs	LabData
CC.F04	CCLCPH	(8,3)	NUM	8	Peak Height, by 8 LCICs, by 3 Ions	LabData
CC.F05	CCISPH	(5)	NUM	8	Peak Height, by 5 Int. Stds. (Primary Ion)	LabData
CC.F06	CCPYRPH		NUM	8	Peak Height Pyrene-D10 (Secondary Ion)	LabData
CC.F07	CCSSPH	(3)	NUM	8	Peak Height, by 3 Surrogates (Primary Ion)	LabData
CC.F08	CCHLCS	(8,3)	NUM	8	Scan for Peak Height, by 8 LCICs, by 3 Ions	LabData
CC.F09	CCHLCR	(8,3)	NUM	8	Retention Time for Peak Height, by 8 LCICs, by 3 Ions	LabData
CC.F10	CCHISS	(5)	NUM	8	Scan for Peak Height, by 5 Int. Stds.,	LabData
CC.F11	CCHISR	(5)	NUM	8	Retention Time for Peak Height, by 5 Int. Stds.	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
CC.F12	CCHPYRS		NUM	8	Scan for Peak Height for Pyrene-D10	LabData
CC.F13	CCHPYRR		NUM	8	Retention Time for Peak Height for Pyrene-D10	LabData
CC.F14	CCHSSS	(3)	NUM	8	Scan for Peak Height, by 3 Surrogates	LabData
CC.F15	CCHSSR	(3)	NUM	8	Retention Time for Peak Height, by 3 Surrogates	LabData

******* Correction Flags (For CC/PC1 ONLY) **

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
CC.G01	CCCDATE		CHAR	1	Analysis Lab Analysis Date	LabData
CC.G02	CCCTIME		CHAR	1	Analysis Lab Analysis Time	LabData
CC.G03	CCCANAL		CHAR	1	Analyst	LabData
CC.G04	CCCLCA	(8,3)	CHAR	1	Area, by 8 LCICs, by 3 Ions	LabData
CC.G05	CCCLCS	(8,3)	CHAR	1	Scan, by 8 LCICs, by 3 Ions	LabData
CC.G06	CCCLCR	(8,3)	CHAR	1	Retention Time, by 8 LCICs, by 3 Ions	LabData
CC.G07	CCCISA	(5)	CHAR	1	Area, by 5 Int. Stds. (Primary Ion)	LabData
CC.G08	CCCISS	(5)	CHAR	1	Scan, by 5 Int. Stds. (Primary Ion)	LabData
CC.G09	CCCISR	(5)	CHAR	1	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
CC.G10	CCCPYRA		CHAR	1	Area Pyrene-D10 (Secondary Ion)	LabData
CC.G11	CCCPYRS		CHAR	1	Scan Pyrene-D10 (Secondary Ion)	LabData
CC.G12	CCCPYRR		CHAR	1	Retention Time Pyrene-D10 (Secondary Ion)	LabData
CC.G13	CCCSSA	(3)	CHAR	1	Area, by 3 Surrogates (Primary Ion)	LabData
CC.G14	CCCSSS	(3)	CHAR	1	Scan, by 3 Surrogates (Primary Ion)	LabData
CC.G15	CCCSSR	(3)	CHAR	1	Retention Time, by 3 Surrogates (Primary Ion)	LabData

******* Analysis Raw Data For CC/PC1 (After Corrections, if any) and PC2 *************************************

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
CC.H01	CCLCA	(2,8,3)	NUM	8	Area, by 2 Analyses, by 8 LCICs, by 3 Ions	LabData
CC.H02	CCLCS	(2,8,3)	NUM	8	Scan, by 2 Analyses, by 8 LCICs, by 3 Ions	LabData
CC.H03	CCLCR	(2,8,3)	NUM	8	Retention Time, by 2 Analyses, by 8 LCICs, by 3 Ions	LabData
CC.H04	CCISA	(2,5)	NUM	8	Area, by 2 Analyses, by 5 Int. Stds. (Primary Ion)	LabData
CC.H05	CCPYRA	(2)	NUM	8	Area Pyrene-D10 (Secondary Ion), by 2 Analyses	LabData
CC.H06	CCISS	(2,5)	NUM	8	Scan, by 2 Analyses, by 5 Int. Stds. (Primary Ion)	LabData
CC.H07	CCPYRS	(2)	NUM	8	Scan Pyrene-D10 (Secondary Ion), by 2 Analyses	LabData
CC.H08	CCISR	(2,5)	NUM	8	Retention Time, by 2 Analyses, by 5 Int. Stds. (Primary Ion)	LabData
CC.H09	CCPYRR	(2)	NUM	8	Retention Time Pyrene-D10 (Secondary Ion), by 2 Analyses	LabData
CC.H10	CCSSA	(2,3)	NUM	8	Area, by 2 Analyses, by 3 Surrogates (Primary Ion)	LabData
CC.H11	CCSSS	(2,3)	NUM	8	Scan, by 2 Analyses, by 3 Surrogates (Primary Ion)	LabData
CC.H12	CCSSR	(2,3)	NUM	8	Retention Time, by 2 Analyses,	LabData

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
					by 3 Surrogates (Primary Ion)	
******* LabData Computations for Continuing Calibration *******						
CC.I01	CCRFA	(11,3)	NUM	8	Response Factors using Area, by 8 LCICs and 3 Surrogates, by 3 Ions	*LabData
CC.I02	CCRFPH	(11,3)	NUM	8	Response Factors using Peak Height, by 8 LCICs and 3 Surrogates, by 3 Ions	*LabData
CC.I03	CCRIR	(11)	NUM	8	Target Ion Ratios for Id Criteria using Theoretical Values, by 8 LCICs and 3 Surrogates	LabData
CC.I04	CCPDRF	(11)	NUM	8	% Dev. From Mean of Response Factors, by 8 LCICs and 3 Surrogates	LabData
CC.I05	CCPDC	(11)	NUM	8	% Dev. Criteria, by 8 LCICs and 3 Surrogates	LabData
CC.I06	CCPDF	(11)	CHAR	1	Flag for % Dev out of criteria, by 8 LCICs and 3 Surrogates	LabData
CC.I07	CCPDOUT		NUM	8	Number of % Dev Out of Criteria	LabData
CC.I08	CCRR	(8,3)	NUM	8	Relative Retention Time, by 8 LCICs, by 3 Ions	*LabData
******* LabData Performance Check Data *******						
CC.J01	PCIR	(2,9)	NUM	8	Ion Ratios, by 2 analyses (PC1, PC2), by 8 LCICs and Pyrene-D10	*LabData
CC.J02	PCIRLC	(2,9)	NUM	8	Ion Criteria lower value, by 2 analyses (PC1, PC2), by 8 LCICs and Pyrene-D10	LabData
CC.J03	PCIRUC	(2,9)	NUM	8	Ion Criteria upper value, by 2 analyses (PC1, PC2), by 8 LCICs and Pyrene-D10	LabData
CC.J04	PCIRF	(2,9)	CHAR	1	Flag for Ion ratio Out of Criteria, by 2 analyses (PC1, PC2), by 8 LCICs and Pyrene-D10	*LabData
CC.J05	PCIROUT	(2)	NUM	8	Number of PC Vals Out of Criteria, by 2 analyses (PC1, PC2)	LabData
CC.J06	PCBLSEP		CHAR	1	Baseline Separation	LabData
CC.J07	PCPV	(3)	NUM	8	% valley (PC1/CNP, PC2/CNP, PC2/BHC)	LabData
CC.J08	PCPVF	(3)	CHAR	1	Flag for % valley (PC1/CNP, PC2/CNP, PC2/BHC) Out of Criteria	*LabData
CC.J09	PCPVC	(3)	NUM	8	% Valley Criteria (PC1/CNP, PC2/CNP, PC2/BHC)	LabData
CC.J10	PCSNR	(2,2)	NUM	8	Signal to Noise Ratio(PC1/BHC,PC2/BHC,PC1/TeBB,PC2/TeBB)	LabData
CC.J11	PCSNRF	(2,2)	CHAR	1	Signal to Noise Ratio Out of Crit. Flag (PC1/BHC,PC2/BHC,PC1/TeBB,PC2/TeBB)	*LabData
CC.J12	PCSNRC	(2,2)	NUM	8	Signal to Noise Ratio(PC1/BHC,PC2/BHC,PC1/TeBB,PC2/TeBB) Criteria	LabData
******* Data Validation Flags *******						
CC.K01	DVDELIV		CHAR	1	Are all deliverables present	DataVal
CC.K02	DVMISS	(7)	CHAR	40	Missing deliverables	DataVal
CC.K03	DVRES	(7)	CHAR	8	Dates resolved	DataVal
CC.K04	DVPC1A		CHAR	1	PC1 Compare percent valley SICPS	DataVal

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
CC.K05	DVPC1B		CHAR	1	PC1 Compare signal to noise ratios with raw data	DataVal
CC.K06	DVPC1C		CHAR	1	PC1 Check ion ratio criteria	DataVal
CC.K07	DVPC1D		CHAR	2	PC1 Check chromatography	DataVal
CC.K08	DVPC1E		CHAR	2	PC1 Check quantitation reports for evidence of editing	DataVal
CC.K09	DVPC1F		CHAR	2	PC1 Miscellaneous	DataVal
CC.K10	DVPC1DT		CHAR	8	PC1 Date	DataVal
CC.K11	DVPC1TM		CHAR	8	PC1 Time	DataVal
CC.K12	DVPCMDP		CHAR	1	Is this a PC2 midpoint for 16 hour analytical run?	DataVal
CC.K13	DVHALF		CHAR	12	First half shift result file name if exists	DataVal
CC.K14	DVPC1CM	(3)	CHAR	60	PC1 Comments	DataVal
CC.K15	DVPC2A		CHAR	1	PC2 Compare percent valley SICPS	DataVal
CC.K16	DVPC2B		CHAR	1	PC2 Compare signal to noise ratios with raw data	DataVal
CC.K17	DVPC2C		CHAR	1	PC2 Check ion ratio criteria	DataVal
CC.K18	DVPC2D		CHAR	2	PC2 Check chromatography	DataVal
CC.K19	DVPC2E		CHAR	2	PC2 Check quantitation reports for evidence of editing	DataVal
CC.K20	DVPC2F		CHAR	2	PC2 Miscellaneous	DataVal
CC.K21	DVPC2DT		CHAR	8	PC2 Date	DataVal
CC.K22	DVPC2TM		CHAR	8	PC2 Time	DataVal
CC.K23	DVPC2CM	(3)	CHAR	60	PC2 Comments	DataVal
CC.K24	DVEPAA		CHAR	2	EPA Chk. Std. Recoveries within acceptance windows	DataVal
CC.K25	DVEPAB		CHAR	2	EPA Chk. Std. Check chromatography	DataVal
CC.K26	DVEPAC		CHAR	2	EPA Chk. Std. Check quantitation reports	DataVal
CC.K27	DVEPAD		CHAR	2	EPA Chk. Std. Miscellaneous	DataVal
CC.K28	DVEPASMP		CHAR	10	EPA Chk. Std. Sample Id	DataVal
CC.K29	DVEPACM	(3)	CHAR	60	EPA Comments	DataVal
CC.K30	DVCCCALA		CHAR	1	Continuing Calibration Internal standard areas	DataVal
CC.K31	DVCCCALB		CHAR	1	Continuing Calibration Check retention time differences	DataVal
CC.K32	DVCCCALC		CHAR	2	Continuing Calibration Miscellaneous	DataVal
CC.K33	DVCCDT		CHAR	8	Continuing Calibration Date	DataVal
CC.K34	DVCCTM		CHAR	8	Continuing Calibration Time	DataVal
CC.K35	DVCCCOM	(3)	CHAR	60	Continuing Calibration Comments	DataVal
******* Integrated DB Audit System Flags **						
CC.L01	CCRECALC		CHAR	1	Flag for calculation descrepancies	IntDBBld

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Keys *******						
CA.A01	CCANALID		CHAR	23	Continuing Calibration/Performance Check 1 Id (Lab Id + Lab Analysis Id of CC/PC1)	LabData
******* Data Transfer Tracking *******						
CA.B01	CCGENDTE		NUM	8	LabData Gen Date	LabData
CA.B02	CCGENTME		NUM	8	LabData Gen Time	LabData
CA.B03	CCADDDTE		NUM	8	DB Add Date	IntDBBld
CA.B04	CCADDTME		NUM	8	DB Add Time	IntDBBld
CA.B05	CCUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
CA.B06	CCUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
CA.B07	CCUPDCNT		NUM	8	DB Update Count	IntDBBld
******* Data Replaced by Corrections *******						
CA.C01	CCLCA	(2,8,3)	NUM	8	Area, by 2 Analyses, by 8 LCICs, by 3 Ions	LabData
CA.C02	CCLCS	(2,8,3)	NUM	8	Scan, by 2 Analyses, by 8 LCICs, by 3 Ions	LabData
CA.C03	CCLCR	(2,8,3)	NUM	8	Retention Time, by 2 Analyses, by 8 LCICs, by 3 Ions	LabData
CA.C04	CCISA	(2,5)	NUM	8	Area, by 2 Analyses, by 5 Int. Stds. (Primary Ion)	LabData
CA.C05	CCPYRA	(2)	NUM	8	Area Pyrene-D10 (Secondary Ion), by 2 Analyses	LabData
CA.C06	CCISS	(2,5)	NUM	8	Scan, by 2 Analyses, by 5 Int. Stds. (Primary Ion)	LabData
CA.C07	CCPYRS	(2)	NUM	8	Scan Pyrene-D10 (Secondary Ion), by 2 Analyses	LabData
CA.C08	CCISR	(2,5)	NUM	8	Retention Time, by 2 Analyses, by 5 Int. Stds. (Primary Ion)	LabData
CA.C09	CCPYRR	(2)	NUM	8	Retention Time Pyrene-D10 (Secondary Ion), by 2 Analyses	LabData
CA.CC0	CCSSA	(2,3)	NUM	8	Area, by 2 Analyses, by 3 Surrogates (Primary Ion)	LabData
CA.CC1	CCSSS	(2,3)	NUM	8	Scan, by 2 Analyses, by 3 Surrogates (Primary Ion)	LabData
CA.CC2	CCSSR	(2,3)	NUM	8	Retention Time, by 2 Analyses, by 3 Surrogates (Primary Ion)	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Keys and Status**						
QC.A01	QCANALID		CHAR	23	QC Lab Analysis Id - (Lab Id + Lab Analysis Id)	LabData
QC.A02	QCSTATUS		CHAR	1	Status Flag	IntDBBld
QC.A03	CLEANHS		CHAR	8	Original Project Id (HS Number)	IntDBBld
******* Chronology **						
QC.B01	QCALDTE		NUM	8	Analysis Lab Login Date	LabData
QC.B02	QCAEDTE		NUM	8	Analysis Lab Extract Date	LabData
QC.B03	QCAADTE		NUM	8	Analysis Lab Analysis Date	LabData
QC.B04	QCAATME		NUM	8	Analysis Lab Analysis Time	LabData
QC.B05	QCDBDTE		NUM	8	Data Validation Date	DataVal
******* Data Transfer Tracking **						
QC.C01	QCGENDTE		NUM	8	LabData Gen Date	LabData
QC.C02	QCGENTME		NUM	8	LabData Gen Time	LabData
QC.C03	QCADDDTE		NUM	8	DB Add Date	IntDBBld
QC.C04	QCADDTME		NUM	8	DB Add Time	IntDBBld
QC.C05	QCUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
QC.C06	QCUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
QC.C07	QCUPDCNT		NUM	8	DB Update Count	IntDBBld
******* Analysis Lab Sample Login Data **						
QC.D01	QCSMPL		CHAR	8	QC Sample Id from LabData (the Project Sample Id)	LabData
QC.D02	QCALID		CHAR	3	Analytic Laboratory Id	LabData
QC.D03	QCRERUN		CHAR	2	Re-run Flag	currently not used
QC.D04	QCRRSTAT		CHAR	1	Re-run Type	currently not used
QC.D05	QCORIG		CHAR	1	Orig. Found Flag	currently not used
QC.D06	QCTYPE		CHAR	6	QC Sample Type	LabData
******* Analysis Lab Sample Extraction Data **						
QC.E01	QCTWTEXT		NUM	8	Target Weight to Extract (gm)	LabData
QC.E02	QCWTEXT		NUM	8	Weight Extracted (gm)	LabData
QC.E03	QCMOIST		NUM	8	Percent Moisture	LabData
QC.E04	QCCONCDF		NUM	8	Concentration Dilution Factor	LabData
******* Analysis Lab Injection Data **						
QC.F01	QCINSTID		CHAR	15	GC/MS Instrument Id	LabData
QC.F02	QCANLST		CHAR	8	GC/MS Analyst	LabData
QC.F03	QCFILE		CHAR	15	GC/MS Datafile Id	LabData
QC.F04	QCINJVOL		NUM	8	Injection Volume (ul)	LabData
******* Analysis Lab Interpretation Data **						
QC.G01	QCQFILE		CHAR	12	GC/MS Shift Results File Name	LabData
QC.G02	QCQMTH	(8,3)	CHAR	1	Quantitation Method Flag, by 8 LCICs, by 3 Ions	LabData
QC.G03	QCQION	(8)	CHAR	1	LCIC Quantitation Ion Selection, by 8 LCICs	LabData
QC.G04	QCLCPH	(8,3)	NUM	8	Peak Height, by 8 LCICs, by 3 Ions	LabData
QC.G05	QCISPH	(5)	NUM	8	Peak Height, by 5 Int. Stds. (Primary Ion)	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
QC.G06	QCPYRPH		NUM	8	Peak Height Pyrene-D10 (Secondary Ion)	LabData
QC.G07	QCSSPH	(3)	NUM	8	Peak Height, by 3 Surrogates (Primary Ion)	LabData
QC.G08	QCHLCS	(8,3)	NUM	8	Scan for Peak Height, by 8 LCICs, by 3 Ions	LabData
QC.G09	QCHLCR	(8,3)	NUM	8	Retention Time for Peak Height, by 8 LCICs, by 3 Ions	LabData
QC.G10	QCHISS	(5)	NUM	8	Scan for Peak Height, by 5 Int. Stds.	LabData
QC.G11	QCHISR	(5)	NUM	8	Retention Time for Peak Height, by 5 Int. Stds.	LabData
QC.G12	QCHPYRS		NUM	8	Scan for Peak Height for Pyrene-D10	LabData
QC.G13	QCHPYRR		NUM	8	Retention Time for Peak Height for Pyrene-D10	LabData
QC.G14	QCHSSS	(3)	NUM	8	Scan for Peak Height, by 3 Surrogates	LabData
QC.G15	QCHSSR	(3)	NUM	8	Retention Time for Peak Height, by 3 Surrogates	LabData
******* Correction Flags ***						
QC.H01	QCCDATE		CHAR	1	Analysis Lab Analysis Date	LabData
QC.H02	QCCTIME		CHAR	1	Analysis Lab Analysis Time	LabData
QC.H03	QCCANAL		CHAR	1	Analyst	LabData
QC.H04	QCCLCA	(8,3)	CHAR	1	Area, by 8 LCICs, by 3 Ions	LabData
QC.H05	QCCLCS	(8,3)	CHAR	1	Scan, by 8 LCICs, by 3 Ions	LabData
QC.H06	QCCLCR	(8,3)	CHAR	1	Retention Time, by 8 LCICs, by 3 Ions	LabData
QC.H07	QCCISA	(5)	CHAR	1	Area, by 5 Int. Stds. (Primary Ion)	LabData
QC.H08	QCCISS	(5)	CHAR	1	Scan, by 5 Int. Stds. (Primary Ion)	LabData
QC.H09	QCCISR	(5)	CHAR	1	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
QC.H10	QCCPYRA		CHAR	1	Area Pyrene-D10 (Secondary Ion)	LabData
QC.H11	QCCPYRS		CHAR	1	Scan Pyrene-D10 (Secondary Ion)	LabData
QC.H12	QCCPYRR		CHAR	1	Retention Time Pyrene-D10 (Secondary Ion)	LabData
QC.H13	QCCSSA	(3)	CHAR	1	Area, by 3 Surrogates (Primary Ion)	LabData
QC.H14	QCCSSS	(3)	CHAR	1	Scan, by 3 Surrogates (Primary Ion)	LabData
QC.H15	QCCSSR	(3)	CHAR	1	Retention Time, by 3 Surrogates (Primary Ion)	LabData
******* Analysis Raw Data (After Corrections, if any) ***						
QC.I01	QCLCA	(8,3)	NUM	8	Area, by 8 LCICs, by 3 Ions	LabData
QC.I02	QCLCS	(8,3)	NUM	8	Scan, by 8 LCICs, by 3 Ions	LabData
QC.I03	QCLCR	(8,3)	NUM	8	Retention Time, by 8 LCICs, by 3 Ions	LabData
QC.I04	QCISA	(5)	NUM	8	Area, by 5 Int. Stds. (Primary Ion)	LabData
QC.I05	QCPYRA		NUM	8	Area Pyrene-D10 (Secondary Ion)	LabData
QC.I06	QCISS	(5)	NUM	8	Scan, by 5 Int. Stds. (Primary Ion)	LabData
QC.I07	QCPYRS		NUM	8	Scan Pyrene-D10 (Secondary Ion)	LabData
QC.I08	QCISR	(5)	NUM	8	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
QC.I09	QCPYRR		NUM	8	Retention Time Pyrene-D10 (Secondary Ion)	LabData
QC.I10	QCSSA	(3)	NUM	8	Area, by 3 Surrogates (Primary Ion)	LabData
QC.I11	QCSSS	(3)	NUM	8	Scan, by 3 Surrogates (Primary Ion)	LabData
QC.I12	QCSSR	(3)	NUM	8	Retention Time, by 3 Surrogates (Primary Ion)	LabData
******* LabData Computations for Field and QC Samples **						
QC.J01	QCRR	(8)	NUM	8	Relative Retention Time, by 8 LCICs (Quantitation Ion)	*LabData
QC.J02	QCRRC	(8)	NUM	8	Relative Retention Time Criteria, by 8 LCICs	LabData

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
QC.J03	QCRRF	(8)	CHAR	1	Flag for Rel. Ret. Time Out of Criteria, by 8 LCICs	*LabData
QC.J04	QCCONCB	(8)	NUM	8	PreID-criteria Concentration, by 8 LCICs (i.e.,primary ion equivalent concentration)	*LabData
QC.J05	QCCONCA	(8)	NUM	8	Id Criteria applied Concentration, by 8 LCICs	*LabData
QC.J06	QCIRAT	(8)	NUM	8	Ion Ratio, by 8 LCICs	*LabData
QC.J07	QCIONF	(8)	CHAR	1	Flag for All Ions Being Present, by 8 LCICs	*LabData
QC.J08	QCMINS	(8)	NUM	8	Minimum Scan Number of 3 Ions, by 8 LCICs	LabData
QC.J09	QCMAXS	(8)	NUM	8	Maximum Scan Number of 3 Ions, by 8 LCICs	LabData
QC.J10	QCRANG	(8)	NUM	8	Scan Range (Max - Min), by 8 LCICs	*LabData
QC.J11	QCRANGF	(8)	CHAR	1	Flag for Scan range >2, by 8 LCICs	*LabData
QC.J12	QCIDEVT	(8)	NUM	8	Ion Ratio % Dev. from Theoretical Values, by 8 LCICs	*LabData
QC.J13	QCIDEVF	(8)	CHAR	1	Flag for Ion ratio % Dev. Out of Criteria, by 8 LCICs	*LabData
QC.J14	QCPRESCR		CHAR	3	Flag for Analysis Pre-screen	LabData
QC.J15	QCSULFUR		CHAR	1	Flag for Sulphur Cleanup Performed	LabData
******* LabData Computations for Surrogate Standards **						
QC.K01	QCPR	(3)	NUM	8	% Recovery by 3 Surrogates	*LabData
QC.K02	QCPRF	(3)	CHAR	1	Flag for % Rec. Out of Criteria, by 3 Surrogates	*LabData
QC.K03	QCSSADD	(3)	NUM	8	Amount of added(ng), by 3 Surrogates	LabData
QC.K04	QCPRCL	(3)	NUM	8	% Recovery Criteria lower limit, by 3 Surrogates	LabData
QC.K05	QCPRCU	(3)	NUM	8	% Recovery Criteria upper limit, by 3 Surrogates	LabData
QC.K06	QCPROUT		NUM	8	Number of % Rec. Out of Criteria	*LabData
******* LabData Computations for Internal Standards ***						
QC.L01	QCISADD		NUM	8	Internal Standard Quantity Added (in nanograms)	LabData
QC.L02	QCRD	(5)	NUM	8	Ret. Time Difference From CC Val, by 5 Int Stds	*LabData
QC.L03	QCAD	(5)	NUM	8	Area Difference % From CC Val, by 5 Int Stds	*LabData
QC.L04	QCRF	(5)	CHAR	1	Flag for Ret. Time Out of Criteria, by 5 Int Stds	*LabData
QC.L05	QCAF	(5)	CHAR	1	Flag for Area Out of Criteria, by 5 Int Stds	*LabData
QC.L06	QCRDC	(5)	NUM	8	Retention Time Difference Criteria, by 5 Int Stds	LabData
QC.L07	QCADCL	(5)	NUM	8	Area % Diff. Crit. lower limit, by 5 Int Stds	LabData
QC.L08	QCADCU	(5)	NUM	8	Area % Diff. Crit. upper limit, by 5 Int Stds	LabData
******* LabData Computations for Method Holding Blank ***						
QC.M01	QCSICON	(8)	NUM	8	Concentration, by 8 LCICs (secondary ion)	*LabData
QC.M02	QCTICON	(8)	NUM	8	Concentration, by 8 LCICs (tertiary ion)	*LabData
QC.M03	QCMAXCON		NUM	8	Maximum Conc. Criteria	LabData
QC.M04	QCCONF	(8,3)	CHAR	1	Concentration Out of Criteria Flag, by 8 LCICs, by 3 Ions	*LabData
******* LabData Matrix Spike Data ***						
QC.N01	QCSADDED		NUM	8	Amount of Spike Added (ng)	LabData
QC.N02	QCSRECV	(8)	NUM	8	Amount of Spike Recovered (ng), by 8 LCICs	*LabData
QC.N03	QCSPRCU	(8)	NUM	8	% Recovery Upper Limit Criteria, by 8 LCICs	LabData
QC.N04	QCSPRCL	(8)	NUM	8	% Recovery Lower Limit Criteria, by 8 LCICs	LabData
QC.N05	QCSPRL	(8)	NUM	8	% Recovery Relative % Dev. Limit, by 8 LCICs	LabData
QC.N06	QCSPR	(8)	NUM	8	% Recovery, by 8 LCICs	*LabData

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DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
QC.N07	QCSPDD	(8)	NUM	8	Relative % Dev. of MS/MSD % Recoveries, by 8 LCICs	*LabData
******* Data Validation Flags and Comments *******						
QC.001	DVCHKA		CHAR	2	Recoveries within acceptance criteria	DataVal
QC.002	DVCHKB		CHAR	2	Check chromatography	DataVal
QC.003	DVCHKC		CHAR	2	Check quantitation reports	DataVal
QC.004	DVCHKD		CHAR	2	Blind QC Samples Miscellaneous	DataVal
QC.005	DVSAMP		CHAR	10	Sample Id	DataVal
QC.006	DVCOM	(3)	CHAR	60	Blind QC comments	DataVal
QC.009	QCSURRA		CHAR	1	Check surrogates spiked into all samples	DataVal
QC.010	QCSURRB		CHAR	1	Recoveries within criteria	DataVal
QC.011	QCSURRC		CHAR	1	Miscellaneous	DataVal
QC.012	QCSURCM	(3)	CHAR	60	Surrogates Comments	DataVal
QC.015	QCINTA		CHAR	1	Internal Standards RT Criteria	DataVal
QC.016	QCINTB		CHAR	1	Internal Standards Area Criteria	DataVal
QC.017	QCINTC		CHAR	1	Internal Standards Miscellaneous	DataVal
QC.018	QCINTCM	(3)	CHAR	60	Internal Standards Comments	DataVal
QC.021	QCIDA		CHAR	1	Id All ions maximize simultaneously	DataVal
QC.022	QCIDB		CHAR	1	Id Appropriate flags used	DataVal
QC.023	QCIDC		CHAR	1	Id All peaks reported that meet Id criteria	DataVal
QC.024	QCIDD		CHAR	2	Id Low level peaks examined	DataVal
QC.025	QCIDE		CHAR	2	Id Miscellaneous	DataVal
QC.026	QCIDCOM	(3)	CHAR	60	Id Comments	DataVal
QC.029	QCQTA		CHAR	1	Quantitation Appropriate RRF's used if nonstandard	DataVal
QC.030	QCQTB		CHAR	1	Quantitation Check integration parameters if manual	DataVal
QC.031	QCQTC		CHAR	2	Quantitation Miscellaneous	DataVal
QC.032	QCQTCOM	(3)	CHAR	60	Quantitation Comments	DataVal
QC.035	QCGENA		CHAR	2	General Review case narrative and address all problems	DataVal
QC.036	QCGENB		CHAR	2	Examine SICPS	DataVal
QC.037	QCGENC		CHAR	2	Examine quantitation reports	DataVal
QC.038	QCGEND		CHAR	2	Miscellaneous	DataVal
QC.039	QCGENCM	(3)	CHAR	60	General Comments	DataVal
QC.042	QCDQ	(8,5)	CHAR	2	Data Qualifiers 8 Analytes by 5 samples	DataVal
******* Integrated DB Audit System Flags *******						
QC.P01	QCF1FLAG		CHAR	1	Flag for Form1 Match Results	IntDBBld
QC.P02	QCRECALC		CHAR	1	Flag for calculation descrepancies	IntDBBld

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Keys **						
QA.A01	QCANALID		CHAR	23	QC Lab Analysis Id - (Lab Id + Lab Analysis Id)	LabData
******* Data Transfer Tracking **						
QA.B01	QCGENDTE		NUM	8	LabData Gen Date	LabData
QA.B02	QCGENTME		NUM	8	LabData Gen Time	LabData
QA.B03	QCADDDTE		NUM	8	DB Add Date	IntDBBld
QA.B04	QCADDTME		NUM	8	DB Add Time	IntDBBld
QA.B05	QCUPDDTE		NUM	8	DB Most Recent Update Date	IntDBBld
QA.B06	QCUPDTME		NUM	8	DB Most Recent Update Time	IntDBBld
QA.B07	QCUPDCNT		NUM	8	DB Update Count	IntDBBld
******* Analysis Raw Data (After Corrections, if any) **						
QA.C01	QCLCA	(8,3)	NUM	8	Area, by 8 LCICs, by 3 Ions	LabData
QA.C02	QCLCS	(8,3)	NUM	8	Scan, by 8 LCICs, by 3 Ions	LabData
QA.C03	QCLCR	(8,3)	NUM	8	Retention Time, by 8 LCICs, by 3 Ions	LabData
QA.C04	QCISA	(5)	NUM	8	Area, by 5 Int. Stds. (Primary Ion)	LabData
QA.C05	QCPYRA		NUM	8	Area Pyrene-D10 (Secondary Ion)	LabData
QA.C06	QCISS	(5)	NUM	8	Scan, by 5 Int. Stds. (Primary Ion)	LabData
QA.C07	QCPYRS		NUM	8	Scan Pyrene-D10 (Secondary Ion)	LabData
QA.C08	QCISR	(5)	NUM	8	Retention Time, by 5 Int. Stds. (Primary Ion)	LabData
QA.C09	QCPYRR		NUM	8	Retention Time Pyrene-D10 (Secondary Ion)	LabData
QA.C10	QCSSA	(3)	NUM	8	Area, by 3 Surrogates (Primary Ion)	LabData
QA.C11	QCSSS	(3)	NUM	8	Scan, by 3 Surrogates (Primary Ion)	LabData
QA.C12	QCSSR	(3)	NUM	8	Retention Time, by 3 Surrogates (Primary Ion)	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Keys and Status **						
F1.A01	F1ANALID		CHAR	20	Analysis Lab Sample Id (Lab Id + Lab Analysis Id)	LabData
F1.A02	CLEANHS		CHAR	10	Original Project ID (HS Number)	LabData
******* Sample Information **						
F1.B01	F1SMPL		CHAR	10	Project Sample Field Id (HS #)	LabData
F1.B02	F1TYPE		CHAR	6	Type of sample	LabData
F1.B03	F1GENDTE		CHAR	8	LabData Generation Date	LabData
F1.B04	F1GENTME		CHAR	8	LabData Generation Time	LabData
F1.B05	F1LDVER		CHAR	5	LabData Software Version	LabData
F1.B06	F1MOIST		NUM	8	Percent Moisture	LabData
F1.B07	F1PRESCR		CHAR	3	Flag for Analysis Pre-screen	LabData
F1.B08	F1SULFUR		CHAR	1	Flag for Sulphur Cleanup Performed	LabData
F1.B09	F1ANLST		CHAR	8	GC/MS Analyst	LabData
F1.B10	F1WTEXT		NUM	8	Weight Extracted	LabData
F1.B11	F1AADTE		CHAR	8	Analysis Date	LabData
F1.B12	F1AATME		CHAR	8	Analysis Time	LabData
F1.B13	F1CONCD		NUM	8	Concentration Dilution Factor	LabData
F1.B14	F1QFILE		CHAR	12	GC/MS Shift Results File Name	LabData
F1.B15	F1DFILE		CHAR	15	GC/MS Data File Id	LabData
******* Summary Sample Data Validation Qualifiers **						
F1.C01	LCICUSE	(8)	CHAR	2	Data validation usability flags, by 8 LCICs	IntDBBld
******* EMSL-LV Sample Specific Data Validation Qualifiers **						
F1.D01	S_FLAG	(4)	CHAR	2	Sample specific qualifiers (1 through 4)	Form1DE
F1.D05	S_FLAG5		CHAR	2	Sample specific qualifier 5 - EMSL-LV data validation rating	Form1DE
******* Analyte Specific LabData and Laboratory Qualifiers **						
F1.E01	E_FLAG1A		CHAR	2	1,2-Dichlorobenzene qualifier A	Form1DE
F1.E02	E_FLAG1B		CHAR	2	1,2-Dichlorobenzene qualifier B	Form1DE
F1.E03	E_FLAG1C		CHAR	2	1,2-Dichlorobenzene qualifier C	Form1DE
F1.E04	E_FLAG1D		CHAR	2	1,2-Dichlorobenzene qualifier D	Form1DE
F1.E05	E_FLAG1E		CHAR	2	1,2-Dichlorobenzene qualifier E	Form1DE
F1.E06	E_FLAG2A		CHAR	2	1,2,4-Trichlorobenzene qualifier A	Form1DE
F1.E07	E_FLAG2B		CHAR	2	1,2,4-Trichlorobenzene qualifier B	Form1DE
F1.E08	E_FLAG2C		CHAR	2	1,2,4-Trichlorobenzene qualifier C	Form1DE
F1.E09	E_FLAG2D		CHAR	2	1,2,4-Trichlorobenzene qualifier D	Form1DE
F1.E10	E_FLAG2E		CHAR	2	1,2,4-Trichlorobenzene qualifier E	Form1DE
F1.E11	E_FLAG3A		CHAR	2	1,2,3,4-Tetrachlorobenzene qualifier A	Form1DE
F1.E12	E_FLAG3B		CHAR	2	1,2,3,4-Tetrachlorobenzene qualifier B	Form1DE

LOVE CANAL HABITABILITY STUDY

DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
F1.E13	E_FLAG3C		CHAR	2	1,2,3,4-Tetrachlorobenzene qualifier C	Form1DE
F1.E14	E_FLAG3D		CHAR	2	1,2,3,4-Tetrachlorobenzene qualifier D	Form1DE
F1.E15	E_FLAG3E		CHAR	2	1,2,3,4-Tetrachlorobenzene qualifier E	Form1DE
F1.E16	E_FLAG4A		CHAR	2	2-Chloronaphthalene qualifier A	Form1DE
F1.E17	E_FLAG4B		CHAR	2	2-Chloronaphthalene qualifier B	Form1DE
F1.E18	E_FLAG4C		CHAR	2	2-Chloronaphthalene qualifier C	Form1DE
F1.E19	E_FLAG4D		CHAR	2	2-Chloronaphthalene qualifier D	Form1DE
F1.E20	E_FLAG4E		CHAR	2	2-Chloronaphthalene qualifier E	Form1DE
F1.E21	E_FLAG5A		CHAR	2	Alpha-BHC qualifier A	Form1DE
F1.E22	E_FLAG5B		CHAR	2	Alpha-BHC qualifier B	Form1DE
F1.E23	E_FLAG5C		CHAR	2	Alpha-BHC qualifier C	Form1DE
F1.E24	E_FLAG5D		CHAR	2	Alpha-BHC qualifier D	Form1DE
F1.E25	E_FLAG5E		CHAR	2	Alpha-BHC qualifier E	Form1DE
F1.E26	E_FLAG6A		CHAR	2	Delta-BHC qualifier A	Form1DE
F1.E27	E_FLAG6B		CHAR	2	Delta-BHC qualifier B	Form1DE
F1.E28	E_FLAG6C		CHAR	2	Delta-BHC qualifier C	Form1DE
F1.E29	E_FLAG6D		CHAR	2	Delta-BHC qualifier D	Form1DE
F1.E30	E_FLAG6E		CHAR	2	Delta-BHC qualifier E	Form1DE
F1.E31	E_FLAG7A		CHAR	2	Beta-BHC qualifier A	Form1DE
F1.E32	E_FLAG7B		CHAR	2	Beta-BHC qualifier B	Form1DE
F1.E33	E_FLAG7C		CHAR	2	Beta-BHC qualifier C	Form1DE
F1.E34	E_FLAG7D		CHAR	2	Beta-BHC qualifier D	Form1DE
F1.E35	E_FLAG7E		CHAR	2	Beta-BHC qualifier E	Form1DE
F1.E36	E_FLAG8A		CHAR	2	Gamma-BHC qualifier A	Form1DE
F1.E37	E_FLAG8B		CHAR	2	Gamma-BHC qualifier B	Form1DE
F1.E38	E_FLAG8C		CHAR	2	Gamma-BHC qualifier C	Form1DE
F1.E39	E_FLAG8D		CHAR	2	Gamma-BHC qualifier D	Form1DE
F1.E40	E_FLAG8E		CHAR	2	Gamma-BHC qualifier E	Form1DE
F1.E41	CONC	(8)	NUM	8	Concentrations, by LCIC Order of the LCICs: 1,2-Dichlorobenzene 1,2,4-Trichlorobenzene 1,2,3,4-Tetrachorobenzene 2-Chloronaphthalene Alpha-BHC Delta-BHC Beta-BHC Gamma-BHC	LabData
F1.E42	EXT_DATE		CHAR	8	Date Sample Extracted	Form1DE
******* Analyte Specific Flags **						
F1.F01	ALLIONS	(8)	CHAR	1	All Ions Flags, by 8 LCICs	LabData
F1.F02	SCANRNG	(8)	CHAR	1	Scan Range Flags, by 8 LCICs	LabData
F1.F03	IONRATI	(8)	CHAR	1	Ion Ratio Flags	LabData
F1.F04	RRT	(8)	CHAR	1	Relative Retention Time Flags	LabData

LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Form 1 Comments **						
F1.G01	COMM	(10)	CHAR	80	Form 1 Comments - containing explanation of manual LabData quantitation override	LabData
******* Integrated DB Audit System Results **						
F1.H01	F1TRACK		CHAR	1	Sample not found in Sample Tracking	

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LOVE CANAL HABITABILITY STUDY
DATA ELEMENT DICTIONARY

DATA ELEMENT ID	NAME	ARRAY	TYPE	LENGTH	DESCRIPTION	SOURCE
******* Key *******						
BQ.A01	QCSMPL		CHAR	8	Sample Id	BlindQC
******* Analyte Spiking Level Data *******						
BQ.B01	QCBOTTLE		CHAR	3	Bottle Number	BlindQC
BQ.B02	QCSPIKE	(8)	NUM	8	Spike Levels, by 8 LCICs in ppb	BlindQC

APPENDIX P
Summary of Health Study on Dioxin Level of Concern

Soil Assessment--2, 3, 7, 8-TCDD

Appendix P
SUMMARY OF HEALTH STUDY ON DIOXIN LEVEL OF CONCERN
SOIL ASSESSMENT--2,3,7,8-TCDD

The 1.0 ppb level of concern for 2,3,7,8-TCDD in residential surface soil was developed based on extrapolations from animal toxicity experiments. The extrapolations are reported in "Health Implications of 2,3,7,8-Tetrachlorobenzo-p-dioxin (TCDD) Contamination in Residential Soil" by Kimbrough, et al. The following quote and figures from the article summarize several of the assumptions on which the level of concern is based.

> To estimate human TCDD intake after exposure to TCDD-contaminated soil in residential areas, we calculated estimates for dermal, ingestion, and inhalation doses. With these estimates (the assumptions on which they are based are outlined in the text, the best estimate of a daily dose at 1 ppb in residential soil (assuming uniform distribution of TCDD in soil at 1.0 ppb) is calculated to be 44.6 pg/d (or 636.5 fg/kg b.w.d for a person weighing 70 kg). In consideration of the range of the estimated VSD and because of the unlikelihood that all of the conservative exposure assessment assumptions will be realized on a continuous or lifetime basis, we have concluded that residential soil levels greater than 1.0 ppb TCDD pose a level of concern. The appropriate degree of concern for which management decisions are made should also consider an evaluation of the specific circumstances at each contaminated site.
>
> Exposure in contaminated residential areas would be greater than in only occasionally frequented commercial areas. In residential areas, levels at or above 1.0 ppb TCDD in soil cannot be considered safe and represent a level of concern. In certain commercial areas, higher levels may present an acceptable risk to nonoccupationally exposed individuals. On ranges and pastures, however, lower soil levels may still be of concern, since TCDD accumulates in the tissues of grazing cattle and rooting swine. (Kimbrough, et al.)

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REFERENCES

Kimbrough, Renate D.; Henry Falk; Paul Stehr; and George Fries. 1984. "Health Implications of 2,3,7,8-Tetrachlorobenzo-p-dioxin (TCDD) Contamination in Residential Soil." Journal of Toxicology and Environmental Health, 14, pp. 47-93.

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APPENDIX Q
Summary of Assumptions for 1.0 ppb Level of Concern

Soil Assessment--2, 3, 7, 8-TCDD

Appendix Q
SUMMARY OF ASSUMPTIONS FOR 1.0 PPB LEVEL OF CONCERN SOIL ASSESSMENT--2,3,7,8-TCDD

The assumptions regarding exposure to 2,3,7,8-TCDD (dioxin) in residential soil as presented in the article summarized in Appendix P are summarized in The National Dioxin Study. The following is taken from The National Dioxin Study report:

MAJOR EXPOSURE ASSUMPTIONS FOR THE RECOMMENDED LEVELS

Recommendations	Exposure Assumptions
CDC Level of Concern for Residential Soil	
General Assumptions	o TCDD has a half-life in soil of 12 yrs.
	o All soil assumed contaminated at same level (100% contamination)
	o Exposure occurs during 6 months of the year and is averaged over a 70-year lifetime.
	o Human body weight--70 kg
	o An increased lifetime risk for cancer of approximately 2.5x10^{-5} would result, assuming an initial soil concentration of 1 ppb and the lower bound for the virtually safe dose.
CDC Exposure Pathway Specific Assumptions	
Ingestion	o Daily soil consumption varied with age: 0 to 9 months 0 g 9 to 18 months 1 g 1-1/2 to 3-1/2 years 10 g 3-1/2 to 5 years 1 g >5 years 0.1 g
	o Absorption in GI tract 30%

MAJOR EXPOSURE ASSUMPTIONS FOR THE RECOMMENDED LEVELS
(continued)

Recommendations	Exposure Assumptions
	Dermal Daily soil contact with skin varied with age: 0 to 9 months 0 g 9 to 18 months 1 g 1-1/2 to 3-1/2 years 10 g 3-1/2 to 15 years 1 g >15 years 0.1 g
	Absorption through skin 1%
Inhalation	o Concentration of TCDD on airborne dust is equivalent to soil. o 15 m^3 of air exchanged/day o 100% of TCDD inhaled is absorbed.

(The National Dioxin Study, U.S. EPA, 1987)

APPENDIX R
Guide to Love Canal Dioxin Soil Sampling Study Quality Assurance Project Plan

Soil Assessment--2, 3, 7, 8-TCDD

Appendix R
GUIDE TO LOVE CANAL DIOXIN SOIL SAMPLING STUDY QUALITY ASSURANCE PROJECT PLAN (QAPP) SOIL ASSESSMENT-2,3,7,8-TCDD

To make the dioxin QAPPs more user-friendly, this guide has been prepared. The two QAPP documents for which this guide is provided are the following:

- Love Canal Dioxin Soil Sampling Quality Assurance Project Plan dated November 3, 1986
- Revisions to Love Canal Dioxin Soil Sampling Study Quality Assurance Project Plan dated April 6, 1987

The background for the two QAPP documents is discussed below. Specific QC criteria for the laboratory analyses are given, and flow charts in Figures R-1 and R-2 provide an overview of the dioxin field and laboratory QA/QC programs, respectively.

BACKGROUND

The Love Canal Dioxin Soil Sampling Study QAPP, dated November 3, 1986, was the document prepared for use by field and laboratory personnel in the collection and analysis of the soil samples collected in November and December 1986. Because of the onset of winter, this document was conditionally approved without a Project Plan from the sample preparation laboratory (Appendix C of the dioxin QAPP), so that the field work could begin. The sample preparation laboratory, UNLV, provided the Project Plan on November 26, 1986. Because of the high moisture content of the samples, the homogenization procedure described in the UNLV Project Plan was ineffective. (Using an electric blender caused clumping of the soil.) UNLV made operational revisions to the Project Plan to describe the revised, "hand-mixing" technique. (The original UNLV Project Plan (11/26/86) and the operational revisions (12/11/86) are now included in the dioxin QAPP as Appendix C: Exhibits A and B, respectively.)

The project's goal was to collect all of the dioxin samples in 1986; however, because of inclement weather, sampling was stopped and was started again in May 1987. Sampling could not begin earlier because the winter thaw left soil with a moisture content too high for study purposes.

Because of the change to the homogenization procedure and because of other minor changes relating to the actual collection of the samples, it was decided that the QAPP should be revised. The change in the homogenization procedure meant that the samples no longer needed to be mixed in a controlled laboratory environment. Hence, the 1987 samples were mixed in the field. The "hand-mixing" procedures described in the revised UNLV Project Plan were included in Appendix A, "Dioxin Soil Sampling Plan." Appendix C, which contained procedures for use at UNLV, no longer applied, and was not included in the revised QAPP. Consequently, only the actual body of the QAPP--Appendix A and Appendix H, "Dioxin Soil Sampling Work Plan," were affected by these changes, and only those portions of the original QAPP were included in the Revisions to Love Canal Dioxin Soil Sampling Study Quality Assurance Project Plan, dated April 6, 1987.

The following summarizes the chapters of both of the QAPPs and their appendices:

- Chapter 1--This chapter discusses the necessity for and the contents of the QAPP.
- Chapter 2--This chapter introduces the Love Canal site and provides background information on why the study was needed.
- Chapter 3--This chapter presents the project organization and explains which organization is responsible for which duties.
- Chapter 4--This chapter defines the quality assurance objectives which, for the dioxin study, were measured by accuracy, completeness, representativeness, and comparability.
- Chapter 5--This chapter references Appendix A, the "Dioxin Soil Sampling Plan," which outlines the procedures for collection of the soil samples. The sample design, which resulted in the identification of locations where the samples were to be collected, is referenced in Chapter 5 and reported in Appendix B. The procedures for sample homogenization at the University of Nevada at Las Vegas are referenced and reported in Appendix C (used during November and December of 1986). Appendix F is referenced which includes portions of the "Users Guide to the Contract Laboratory Program." This User's Guide describes how the samples were to be shipped from the field to the analytical laboratories. Appendix H is referenced which is the "Dioxin Soil Sampling Work Plan," and outlines daily procedures to be followed for sample collections.

- Chapter 6--This chapter describes the sample custody procedures and references Appendix A, the "Dioxin Soil Sampling Plan," for specific details.

- Chapter 7--This chapter references Appendix D, the "Site Safety Plan," and discusses the equipment needing calibration. Equipment used for collected samples did not require calibration.

- Chapter 8--This chapter references Appendix E, the "Statement of Work--Dioxin Analysis," which describes the analytical procedures to be used for the study.

- Chapter 9--This chapter describes data reduction, validation, and reporting, and discusses in detail how information relating to collection and homogenization was to be reported. The chapter references Appendix E for the methodology used to report analytical results.

- Chapter 10--This chapter discusses the QC checks used in the study and explicitly defines the field QC checks. The chapter references Appendix C for the QC checks that were used during the analytical work. Table R-1 is a summary of the dioxin analytical QC requirements used during the study.

- Chapter 11--This chapter describes the parties responsible for performing audits on the procedures used in the study.

- Chapter 12--This chapter references Appendix D, the "Site Safety Plan," which describes the preventive maintenance procedures for the analytical instruments. Field equipment for this study, however, did not require preventive maintenance.

- Chapter 13--This chapter references Appendix I for the data assessment procedures that were to be performed by EPA Region II, and the subsequent analytical results.

- Chapter 14--This chapter describes how corrective measures were to be taken, if necessary.

- Chapter 15--This chapter describes the quality assurance reports.

Table R-1, which follows, provides specific QC requirements for the laboratory analyses.

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Table R-1
SUMMARY OF QC REQUIREMENTS
Soil Assessment--2,3,7,8-TCDD
Prepared by EPA EMSL-LV

QC Requirement	Criteria	Action Required if Out of Criteria
Initial Calibration:		
1. Column Performance	The percent valley between 2,3,7,8-TCDD and peaks from all other isomers must be $\leq$ 25%	ANALYSIS MAY NOT PROCEED UNTIL ALL CRITERIA ARE MET
	The ratio of m/z 320 to m/z 322 for 2,3,7,8-TCDD must be $\geq$ 0.67 and $\leq$ 0.90	
	The ratio of m/z 332 to m/z 334 for $^{13}C_{12}$-2,3,7,8-TCDD must be $\geq$ 0.67 and $\leq$ 0.90	
2. Calibration Criteria	The signal to noise ratio (S/N) must be > 2.5 for m/z 259, 320, and 322 for unlabeled 2,3,7,8-TCDD and 328 for $^{37}Cl_4$-2,3,7,8-TCDD and >10 for m/z 332 and 334 for $^{13}C_{12}$-2,3,7,8-TCDD	
	The percent RSD for the RRF of the triplicate analysis of each standard concentration must not exceed 10%	
	The percent RSD of the mean of the four concentrations must not exceed 10%	
Continuing Calibration:	Must be performed at the beginning and end of each 12-hour period	
1. Column Performance	Same as for Initial Calibration	ANALYSIS MAY NOT PROCEED UNTIL ALL CRITERIA ARE MET

Table R-1
(continued)

QC Requirement	Criteria	Action Required if Out of Criteria
2. Calibration Criteria	S/N same as for Initial Calibration	
	The RRF of the unlabeled 2,3,7,8-TCDD relative to $^{13}C_{12}$-2,3,7,8-TCDD must be within ± 10% of the grand mean RRF from the initial calibration	
FFB (Matrix Blank)	Recovery must be between 60 and 140%	Re-extract and reanalyze the FFB
Method Blank	Must not contain any signal at m/z 320, 322, or 259 which is greater than 2% of the m/z 332 response within ± 5 scans of the m/z 332 peak maximum	Associated positive samples must be re-extracted and reanalyzed
Duplicate Analysis	The RPD must be no greater than 50 percent	Contact SMO or the DPO for resolution Report All Values
Blind Quality Control:		
1. Uncontaminated	Must not contain 2,3,7,8-TCDD (False Positive)	The entire associated batch of samples must be re-extracted and reanalyzed
2. EMSL-LV Performance Evaluation	Must fall within the performance based acceptance windows	The entire associated batch of samples must be re-extracted and reanalyzed
EMPC	Less than 1 ug/Kg	The sample must be re-extracted and reanalyzed

Table R-1
(continued)

QC Requirement	Criteria	Action Required if Out of Criteria
Samples:		
1. Identification	All criteria except ion ratios are met	Sample must be re-extracted and reanalyzed
2. Internal Standard S/N Ratio	Must be greater than 10:1	Sample must be re-extracted and reanalyzed
3. Internal Standard m/z 332/334 ratio	Must be $\geq$ 0.67 and $\leq$ 0.90	Sample must be re-extracted and reanalyzed
4. Native 2,3,7,8-TCDD Present	Concentration must not exceed calibration range	Re-extract and reanalyze a smaller aliquot
5. Internal Standard Recovery	Limits not established	
6. Surrogate S/N Ratio	Limits not established	

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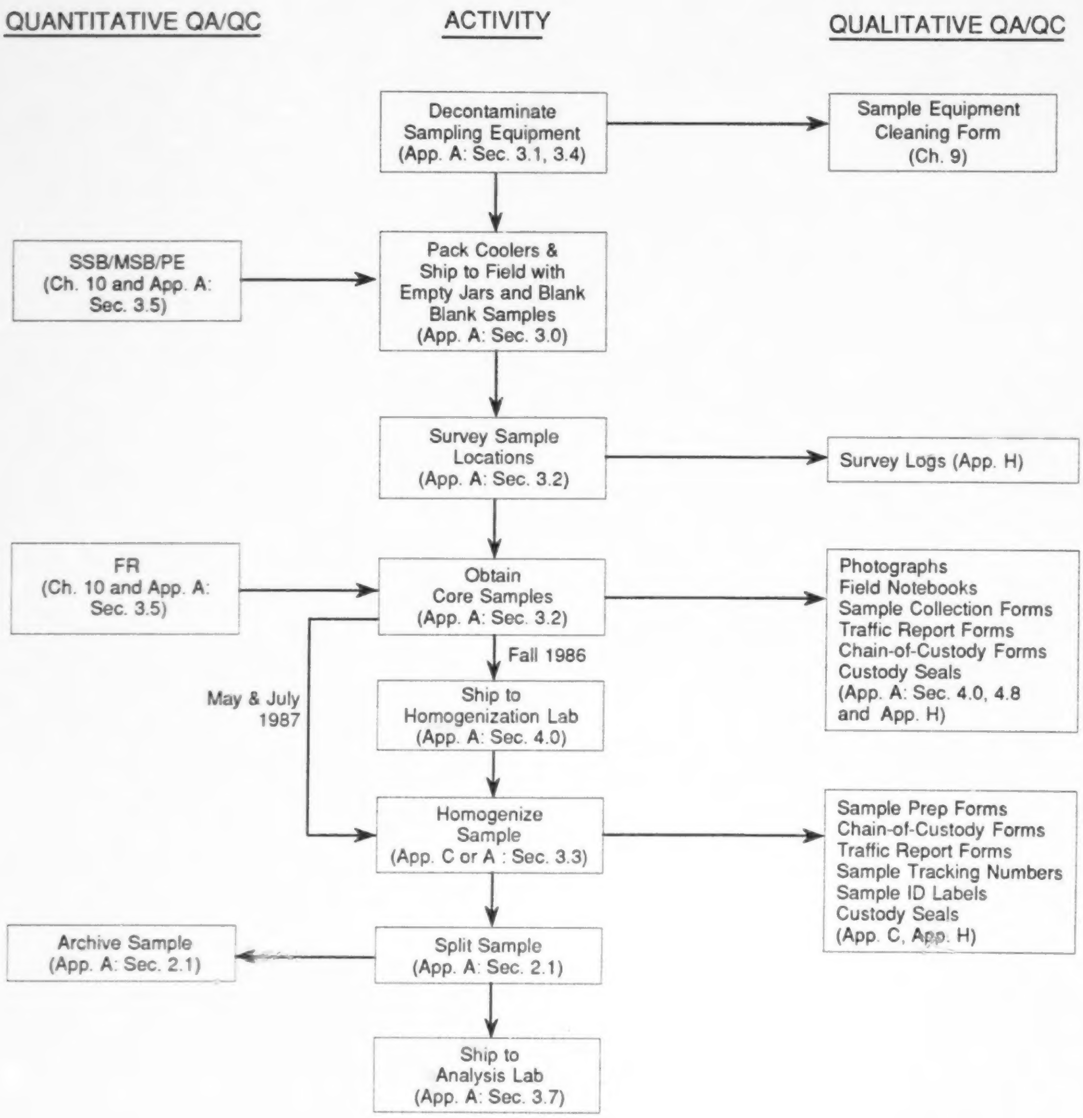
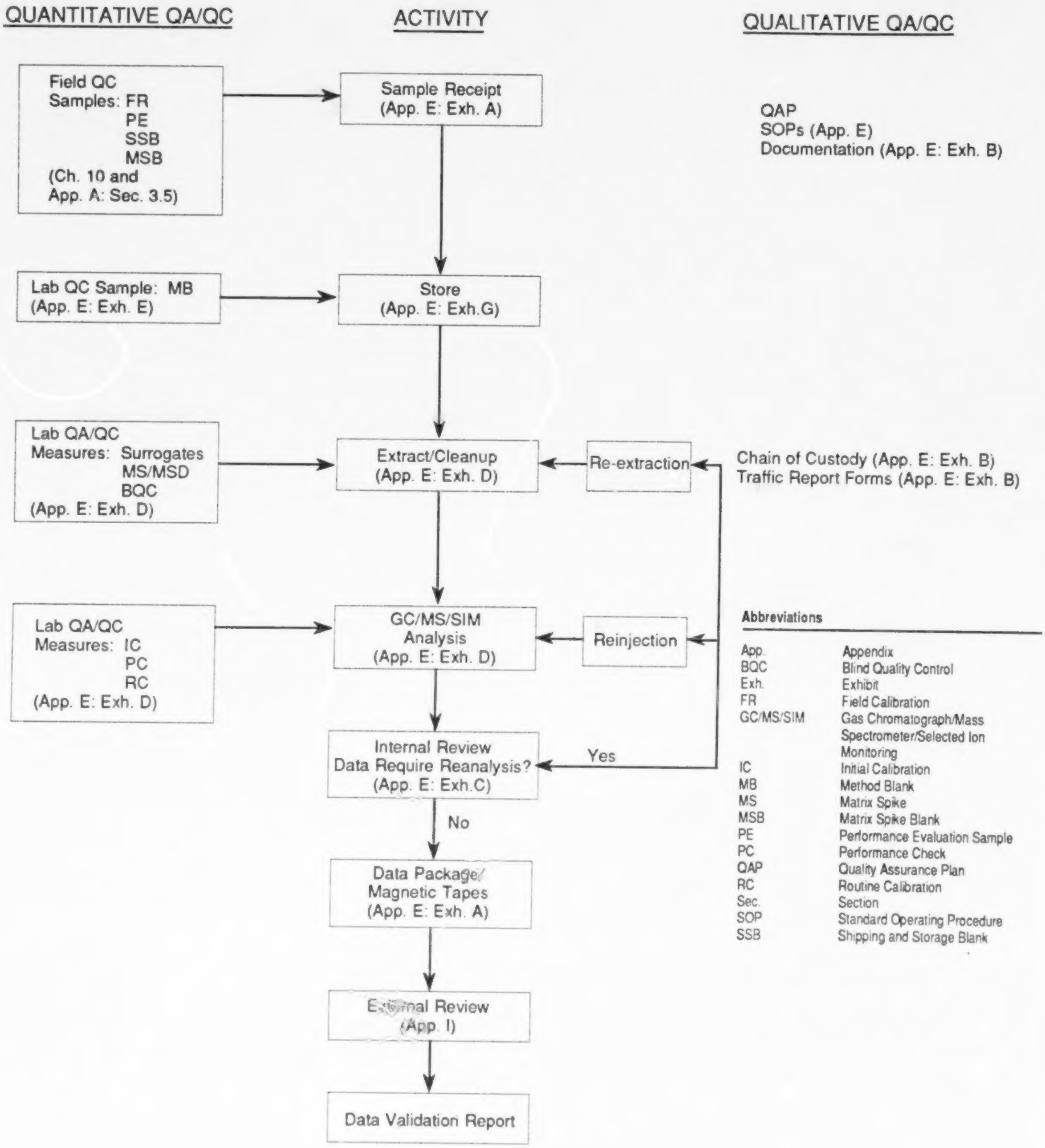

QUANTITATIVE QA/QC
ACTIVITY
QUALITATIVE QA/QC
Decontaminate Sampling Equipment (App. A: Sec. 3.1, 3.4)
Sample Equipment Cleaning Form (Ch. 9)
SSB/MSB/PE (Ch. 10 and App. A: Sec. 3.5)
Pack Coolers & Ship to Field with Empty Jars and Blank Blank Samples (App. A: Sec. 3.0)
Survey Sample Locations (App. A: Sec. 3.2)
Survey Logs (App. H)
FR (Ch. 10 and App. A: Sec. 3.5)
Obtain Core Samples (App. A: Sec. 3.2)
Photographs
Field Notebooks
Sample Collection Forms
Traffic Report Forms
Chain-of-Custody Forms
Custody Seals
(App. A: Sec. 4.0, 4.8 and App. H)
Fall 1986
May & July 1987
Ship to Homogenization Lab (App. A: Sec. 4.0)
Homogenize Sample (App. C or A : Sec. 3.3)
Sample Prep Forms
Chain-of-Custody Forms
Traffic Report Forms
Sample Tracking Numbers
Sample ID Labels
Custody Seals
(App. C, App. H)
Archive Sample (App. A: Sec. 2.1)
Split Sample (App. A: Sec. 2.1)
Ship to Analysis Lab (App. A: Sec. 3.7)

Abbreviations

App.	Appendix
Ch.	Chapter
FR	Field Replicate
MSB	Matrix Spike Blank
PE	Performance Evaluation Sample
Sec.	Section
SSB	Shipping and Storage Blank

Figure R-1
SOIL ASSESSMENT--2, 3, 7, 8-TCDD
SCHEMATIC REPRESENTATION
OF THE FIELD QA/QC PROGRAM
WITH REFERENCE TO QAPP SECTION


QUANTITATIVE QA/QC
ACTIVITY
QUALITATIVE QA/QC
Field QC Samples: FR PE SSB MSB (Ch. 10 and App. A: Sec. 3.5)
Sample Receipt (App. E: Exh. A)
QAP
SOPs (App. E)
Documentation (App. E: Exh. B)
Lab QC Sample: MB (App. E: Exh. E)
Store (App. E: Exh.G)
Lab QA/QC Measures: Surrogates MS/MSD BQC (App. E: Exh. D)
Extract/Cleanup (App. E: Exh. D)
Re-extraction
Chain of Custody (App. E: Exh. B)
Traffic Report Forms (App. E: Exh. B)
Lab QA/QC Measures: IC PC RC (App. E: Exh. D)
GC/MS/SIM Analysis (App. E: Exh. D)
Reinjection
Internal Review Data Require Reanalysis? (App. E: Exh.C)
Yes
No
Data Package/ Magnetic Tapes (App. E: Exh. A)
External Review (App. I)
Data Validation Report

Abbreviations

App.	Appendix
BQC	Blind Quality Control
Exh.	Exhibit
FR	Field Calibration
GC/MS/SIM	Gas Chromatograph/Mass Spectrometer/Selected Ion Monitoring
IC	Initial Calibration
MB	Method Blank
MS	Matrix Spike
MSB	Matrix Spike Blank
PE	Performance Evaluation Sample
PC	Performance Check
QAP	Quality Assurance Plan
RC	Routine Calibration
Sec.	Section
SOP	Standard Operating Procedure
SSB	Shipping and Storage Blank

Figure R-2
SOIL ASSESSMENT--2, 3, 7, 8-TCDD
SCHEMATIC REPRESENTATION
OF THE LABORATORY QA/QC PROGRAM
WITH REFERENCE TO QAPP SECTION

APPENDIX S
Method Validation Report 2, 3, 7, 8-Tetrachlorodibenzo-p-Dioxin in Soil and Sediment by Low Resolution Mass Spectrometry

Prepared by

U.S. EPA Environmental Monitoring Systems Laboratory
Lockheed Engineering and Management Services Company
Las Vegas, Nevada

May 1988

METHOD VALIDATION REPORT
2,3,7,8-TETRACHLORO-DIBENZO-p-DIOXIN
IN SOIL AND SEDIMENT BY
LOW RESOLUTION MASS SPECTROMETRY

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5-1-a

NOTICE

Although the research described in this report has been funded wholly or in part by the United States Environmental Protection Agency through contract number 68-03-3249 to Lockheed Engineering and Management Services Company, it has not been subjected to Agency review and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The United States Environmental Protection Agency's superfund contractor laboratories use the method found in USEPA IFB WA84-A002 to analyze soil/sediment and water samples for the specific isomer 2,3,7,8-tetrachloro-dibenzo-p-dioxin. This method uses isotope dilution gas chromatography mass spectrometry. The precision, accuracy, and other parameters are important in evaluating performance of laboratories and methods. The observed performance of this method in the production-line analysis of more than two thousand soil and sediment samples by four contractor laboratories is presented in this paper.

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ACKNOWLEDGMENT

The authors are grateful for the assistance of K. Huang of Computer Sciences Coorporation in writing programs to summarize the data.

INTRODUCTION

The Environmental Protection Agency's (EPA) Environmental Monitoring Systems Laboratory - Las Vegas (EMSL-LV) is responsible for conducting a quality assurance program in support of the Agency's Superfund Contract Laboratory Program (CLP). The EMSL-LV quality assurance support program includes providing analytical calibration standards and quality control materials, maintaining a quality assurance data base, conducting performance evaluation studies, performing on-site laboratory evaluations, and conducting technical audits of CLP data. Through these activities the EMSL-LV continuously evaluates and documents CLP laboratory and method performance. Analytical methods are continually evaluated and periodically documented. Where these assessments indicate a need for further knowledge about the performance of methods, the EMSL-LV designs and conducts performance evaluation studies to acquire this information. Through these studies areas for improvement of analytical methodology are identified. The objective of this paper is to document the performance of the CLP analytical method for the analysis of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) in soils and sediments. The method has also been adapted for analysis of water samples for 2,3,7,8-TCDD by using the extraction procedure in EPA Method 613. However, an insufficient number of water samples has been analyzed to make any statement of method performance in routine use.

CONCLUSIONS

The precision of the method can be characterized by a percent relative standard deviation of 7.4 percent for fortified field blanks and 12.6 to 23.1 percent for performance evaluation samples. Little, if any, bias exists. The mean percent bias for the fortified field blanks was -4.9 percent, while that of the performance evaluation samples was -27.6 to +6.3 percent. Qualitatively, the method performance is characterized by a false positive rate of one to four percent, and a false negative rate of two to three percent at a concentration of 0.8 to 1.5 µg/kg. The required isomer specificity, which is based on a percent valley criterion of 25 percent, is achieved about 90 percent of the time with the contractually recommended columns. The three sample-specific quality control procedures, the maximum possible concentration, the surrogate signal-to-noise ratio, and the percent recovery of the internal standard were all found to be useful in identifying false negatives.

METHOD DESCRIPTION

The USEPA has a standard method for use by contractor laboratories in analyzing for 2,3,7,8-TCDD in soils and sediments. This method is described in detail in USEPA IFB WA84-A002[1] and by Kleopfer[2]. The method is intended to achieve a detection limit of one µg/kg and to separate 2,3,7,8-TCDD from all other TCDD isomers. Surrogate ($^{37}Cl_4$-2,3,7,8-TCDD) and internal standard ($^{13}C_{12}$-2,3,7,8-TCDD) are added before sample extraction. The sample is then subjected to a jar extraction technique using 150 mL hexane and 20 mL methanol in a shaker for at least 3 hours. The extract is then subjected to cleanup using silica gel, alumina, and Carbopak C. The eluate is concentrated by evaporation under a gentle stream of dry nitrogen before GC/MS SIM analysis. Peak areas are obtained from reconstructed ion current profiles for m/z 257, 320, 322, 328, 332, and 334. The quantity of native TCDD is estimated by calculating the ratio of the sum of the peak areas for m/z 320 and 332 (native TCDD) to the sum of the peak areas for m/z 332 and 334 (internal standard). This ratio is then multiplied by the quantity of internal standard added to the sample and divided by the sample weight and the mean response factor from the 12-point initial calibration to obtain an estimate of the concentration of native TCDD in the sample. Because of the isotope dilution technique, any bias due to incomplete extraction or cleanup losses should be corrected by equivalent losses of the internal standard, provided that enough of each dioxin is recovered to enable identification and quantitation.

The following quality control analyses are routinely performed.

Routine Calibration - The lowest concentration calibration standard (corresponding to 1.0 µg/kg in a 10 gram sample) must be analyzed once at the beginning of each 12-hour period.

Method Blank Analysis - One analysis per case (approximately 24 samples) is performed on laboratory reagents to determine if contamination is occurring.

Surrogate Signal-to-Noise Ratio - The signal to noise ratio of the surrogate is computed for each sample analyzed. The amount added corresponds to 0.14 µg/kg in a 10 gram sample. The signal-to-noise ratio is intended to demonstrate adequate low-level detectability.

Fortified Field Blank Analysis - One sample per case is fortified with 1.0 µg/kg of native TCDD and analyzed to determine if matrix effects are present.

Duplicate Analysis - One sample per case is analyzed twice to determine within-laboratory precision.

Column Performance Check Analysis - A standard solution containing several closely eluting isomers of TCDD is analyzed initially and at the end of each 12-hour period to demonstrate adequate isomer resolution.

Performance Evaluation Sample Analysis - One sample per case is a performance evaluation sample with a known amount of TCDD and interferences. The concentration of this sample is not known by the laboratories. Four well-characterized materials of 1 to 10 µg/kg native TCDD in dry soil are used routinely, as are two blank materials.

Internal Standard Recovery - In each sample the response of the internal standard (added before extraction) is compared to that of the recovery standard (added just before injection). This provides a measure of losses of the internal standard during extraction and cleanup. It is inferred that this provides information on the recovery and detectability of native 2,3,7,8-TCDD.

Maximum Possible Concentration - For each sample in which 2,3,7,8-TCDD is not detected, the maximum possible concentration is calculated. This is an estimate of the highest concentration of 2,3,7,8-TCDD that could be present based on the strength of the observed instrumental response.

LIMITATIONS

The range of calibration corresponds to sample concentrations of 1.0 to 100 µg/kg 2,3,7,8-TCDD. Samples exceeding 100 µg/kg must be reanalyzed using a smaller (1 g) sample aliquot to ensure accuracy, thus effectively extending the calibration range to 1000 µg/kg.

PERFORMANCE DATA

The following statistics and tables are the results of several data reductions of a comprehensive system of databases maintained at the EMSL-LV. These databases include information from 4 contractor laboratories analyzing thousands of real environmental samples from hazardous waste sites across the United States under production-line conditions in commercial laboratories. The information presented represents a realistic appraisal of the performance of the method under routine operating conditions.

PRECISION

The precision of the method is expressed by the percent relative standard deviation (% RSD). This quantity is estimated by the standard deviation of 2,3,7,8-TCDD quantifications divided by the mean, and multiplied by 100 to obtain a percentage. The precision is presented in Table 1 for the fortified field blank analysis, the performance evaluation sample analysis.

TABLE 1. PRECISION

Sample Type	Target Concentration	Number of data	% RSD
Fortified Field Blank	1.0 µg/kg	131	7.4%
Performance Evaluation	0.8 µg/kg	63	12.6%
Performance Evaluation	1.2 µg/kg	49*	14.2%
Performance Evaluation	1.5 µg/kg	34	23.1%

* Two high outliers were removed by Grubb's test.

Inspection of Table 1 reveals that the precision is poorer for the performance evaluation samples than for the fortified field blank analysis. This may be due to the laboratories knowing the target concentration of the fortified field blanks samples, but not the performance evaluation samples. Another possible contributing factor is the much longer time that dioxin is present in the performance evaluation materials.

In a similar study by Garner, Homsher, and Pearson[3], it was found that the precision of the method could be characterized by % RSD values between 10 and 20 percent. It was also found that there was no statistically significant long-term interlaboratory component of variance. For this reason, within-laboratory precision was not displayed separately in Table 1.

ACCURACY

The accuracy is expressed as the percent bias, which is estimated by the difference between the observed concentration and the target concentration, divided by the target concentration, and then multiplied by 100 to obtain a percentage. The accuracy is presented in Table 2 for the fortified field blank analysis and the performance evaluation samples analysis.

TABLE 1. ACCURACY

Sample Type	Target Concentration	Number of data	Mean Bias
Fortified Field Blank	1.0 µg/kg	131	- 4.9%
Performance Evaluation	0.8 µg/kg	63	+ 6.3%
Performance Evaluation	1.2 µg/kg	49*	-27.6%
Performance Evaluation	1.5 µg/kg	34	- 3.5%

* Two high outliers were removed by Grubb's test.

Inspection of Table 2 reveals that substantial bias is not apparent. The 1.2 µg/kg performance evaluation sample shows substantial negative bias (-27.6%), but may simply be due to anomalous preparation of the performance evaluation material. A similar study[3] found that the percent bias could be characterized by values between zero and -20 percent, and that performance evaluation sample analyses tended to be negatively biased.

FALSE POSITIVE RATE

A false positive occurs when native 2,3,7,8-TCDD is identified in a sample which contains no native 2,3,7,8-TCDD. The frequency of occurrence of false positives may be estimated by using the results of the method blank and field blank analyses. Four out of 175 method blank analyses were reported to have identified native 2,3,7,8-TCDD. While this represents a false positive rate of 2.3 percent, it must be noted that none of these samples was reported to contain more than 0.18 µg/kg native TCDD. The maximum permissible concentration of 2,3,7,8-TCDD that may be identified in method blank analyses is 0.3 µg/kg. Five of 127 field blank analyses were reported to have identified native 2,3,7,8-TCDD. Three of these were quantified above 0.3 µg/kg, with values of 0.61, 0.93, and 0.93 µg/kg. The false positive rate of 3.9 percent for field blanks may be more representative of performance for routine environmental samples because the identity of these samples is not revealed to the laboratory. A previous study[3] estimated the false positive rate to be approximately one percent for method blank analyses only.

FALSE NEGATIVE RATE

A false negative occurs when native 2,3,7,8-TCDD is not identified in a sample which actually contains native 2,3,7,8-TCDD. The frequency of false negatives may be observed for the fortified field blank analysis and for the performance evaluation sample analysis. Three out of 134 fortified field blank analyses failed to identify native 2,3,7,8-TCDD, giving an estimated false negative rate of 2.2 percent. Five of the 153 performance evaluation sample analyses failed to identify native 2,3,7,8-TCDD, giving an estimated false negative rate of about 3.3 percent. The performance evaluation sample analysis probably yields the most realistic information pertaining to false negatives, as the laboratories are not informed in advance that native 2,3,7,8-TCDD is actually present in these samples.

SPECIFICITY

The identification criteria for native 2,3,7,8-TCDD are clearly defined in the IFB, and are designed to prevent any other compound from being mistaken for native 2,3,7,8-TCDD. The criteria are based on relative retention time, which must match the internal standard, and on ion ratios. Peaks at mass 259, 320, and 322 must be observed and meet signal-to-noise ratio requirements, and the ratio of integrated ion current at mass 320 to that at mass 322 must be between 0.77 and 0.90. The authors do not know of a single analysis where another compound or isomer was mistaken for 2,3,7,8-TCDD. It was previously shown[3] that the GC columns recommended in the IFB could adequately resolve 2,3,7,8-TCDD from the nearest eluting isomer approximately 90 percent of the time when analyzing the column performance check solution.

QUALITY CONTROL PERFORMANCE

The quality control procedures are an inherent part of the analytical method and, as such, should be described and evaluated with the method. The quality control procedures include estimation of the maximum possible concentration of native 2,3,7,8-TCDD (formerly called the detection limit), estimation of the signal-to-noise ratio of a low-level isotopically-labelled "surrogate" compound, estimation of the percent recovery of the internal standard, duplicate analysis, field blank analysis, fortified field blank analysis, method blank analysis, and performance evaluation sample analysis. Each of these analyses has an important implied role in ensuring the quality of the final results. Comparison of the actual performance of these procedures to the implied quality control objectives will demonstrate their effectiveness.

The maximum possible concentration (MPC) is estimated for each sample in which native 2,3,7,8-TCDD is not identified. The MPC is intended to represent the greatest concentration of 2,3,7,8-TCDD which could be present in a given sample. It is determined by integrating the instrumental response over the appropriate retention time for mass 320 or mass 322, whichever is less, quantifying this result through the calibration response factor, then multiplying by 2.5. The smaller peak is used because potential interferences at the larger peak may have been the cause of failure to identify native 2,3,7,8-TCDD. The multiplier 2.5 was chosen to be sufficiently large to ensure a small probability of the true concentration of native 2,3,7,8-TCDD exceeding the MPC. Approximately 2,500 values of the MPC were observed for analysis of environmental samples. The median value was 0.05 µg/kg, while the 95th percentile was 0.39 µg/kg, and the largest observed value was 80.5 µg/kg. More importantly, it was also observed that for performance evaluation samples in which native 2,3,7,8-TCDD was not identified (presumably through some laboratory error) the MPC usually exceeded the true concentration of native 2,3,7,8-TCDD. Hence the MPC is a useful piece of quality control information.

An isotopically labelled surrogate compound, $^{37}Cl_4$-2,3,7,8-TCDD is added to every sample before extraction. The surrogate is not quantified. A previous work[3] showed the quantification of the surrogate to be poorly correlated with the quantification of native TCDD, which led to the USEPA altering the method. The surrogate is currently added at a very low level, 0.14 µg/kg, to represent the approximate strength of the tertiary ion, mass 259, of native TCDD at 1 μg/kg. The signal-to-noise ratio of the surrogate is measured and reported for every sample. Approximately 2,700 samples had a median reported surrogate signal-to-noise ratio of 28, a 95th percentile of 97, and a maximum of 270. All of the values reported were greater than or equal to 1.0, and 95 percent exceeded 4.3. Values of the surrogate signal-to-noise ratio were examined for the performance evaluation samples in which the laboratory failed to identify native 2,3,7,8-TCDD. Below average signal-to-noise ratios were observed, with a median of about 3.2 and a maximum of 6.7. Hence the surrogate signal-to-noise ratio is a useful piece of quality control information.

The surrogate compound was previously used to demonstrate the accuracy of the analysis for each sample. However, previous work[3] showed that the surrogate accuracy was not closely related to accuracy of the analysis of native TCDD. The surrogate was also much easier to detect than native TCDD at the same concentration, because the surrogate had no ion ratio criteria, no tertiary ion criteria, and the response was concentrated at one molecular mass. Subsequently, it was decided not to use the surrogate compound as an accuracy check. Instead, the current use is as a low-level detectability check.

The internal standard, $^{13}C_{12}$-2,3,7,8-TCDD, is also added to every sample before extraction. The percent recovery of the internal standard is measured against another isotopically-labelled TCDD, the recovery standard, which is added to the extract just before injection. Approximately 2,700 reported values of the percent recovery of the internal standard indicated a median of 48 percent, a 95th percentile of 85 percent, and a maximum of 139 percent. The smallest reported value was 0.0 percent while 95 percent of the reported values exceeded 17 percent. False negatives on performance evaluation samples are generally associated with lower than average percent recoveries of the internal standard, with a median reported value of 9 percent and a maximum of 26 percent. Thus, the percent recovery of the internal standard is a useful piece of quality control information.

Clearly there is some redundancy in the information produced by these quality control procedures. In the authors' opinion, the low level surrogate has the least value of the quality control procedures used and the cost and the benefits of its continued use should be examined. The authors also feel that quality control limits should be placed on the MPC and the percent recovery of the internal standard. A reasonable upper limit for the MPC would be about 1.0 µg/kg, or perhaps a bit lower. A reasonable lower limit for the percent recovery of the internal standard would be somewhere in the range of 10 to 20 percent.

References

1. Invitation for Bid, Solicitation No. WA84-A002, United States Environmental Protection Agency, 400 M Street SW, Washington, D.C., 20460, 1984.

2. Kleopfer, R. 1986. "Dioxin Analytical Methods-General Description and Quality Control Considerations, "Quality Control in Remedial Site Investigation: Hazardous and Industrial Solid Waste Testing, Fifth Volume, ASTM STP 925, C.L. Perket, Ed., American Society for Testing and Materials.

3. Garner, F.C., Homsher, M.T., and Pearson, J.G. 1986. "Performance of USEPA Method for Analysis of 2,3,7,8-Tetrachloro-dibenzo-p-dioxin in Soils and Sediments by Contractor Laboratories," Quality Control in Remedial Site Investigation: Hazardous and Industrial Solid Waste Testing, Fifth Volume, ASTM STP 925, C.L. Perket, Ed., American Society for Testing and Materials.

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APPENDIX T
Retrospective Probability of Detecting the Target-Size Locally Contaminated Area

Soil Assessment--2, 3, 7, 8-TCDD

T-1

Appendix T
RETROSPECTIVE PROBABILITY OF DETECTING THE TARGET-SIZE LOCALLY CONTAMINATED AREA SOIL ASSESSMENT--2,3,7,8-TCDD

In response to the written preliminary comments from Dr. Janick Artiola, a simulation was conducted to determine the retrospective probability of detecting the target-size locally contaminated area using the points sampled during the sampling program for 2,3,7,8-TCDD. In summary, the fact that 14 of the 2,274 points sampled had no valid analytical results could create a high bias. Paved areas larger than the target-size locally contaminated area, which will give a low bias, exist within the EDA. The simulation conducted does not correct for these considerations; thus, the estimate of the retrospective probability is probably lower than that actually achieved. The gross estimate of the retrospective probability of detecting the target-size locally contaminated area is 88 percent.

The following discussion of the simulation is organized in the following sections: "Background," "Scope," and "Results."

BACKGROUND

The sampling program was designed to have a 95 percent probability of detecting a locally contaminated elliptical area approximately 126 feet long by 66 feet wide. This ellipse has an area of approximately 6,500 square feet, which is the median lot size in the EDA.

During the implementation of this sampling plan, several sample locations had to be moved because of the infeasibility of sampling the assigned location (pavement, structure, etc.).

SCOPE

An estimate of the retrospective probability of detecting a locally contaminated area of 6,500 square feet was developed by use of Monte Carlo simulation. The coordinates of the EDA neighborhood boundaries and the points sampled were used as a data base by the simulation. The computer program estimated the probability of detecting a locally contaminated area by generating a simulated locally contaminated area and placing it at a random location and orientation on the map of the EDA. If the simulated area was within the EDA and contained a sampled location, it was counted as a hit. If the simulated area was within the EDA but did not contain a sampled location, it was counted as a miss.

The software for performing the Monte Carlo simulations was implemented on a personal computer-AT (PC-AT) with high-resolution graphics. Graphical displays of maps of the EDA, actual dioxin sampling sites, and the locally contaminated area ellipses were used in the software development process for visual QA/QC. The following sequence of operations was performed by the simulation software:

1. The X-Y coordinates of the boundaries of the 13 EDA neighborhoods were read and loaded into the memory.

2. A map of the EDA was displayed to ensure that the neighborhood boundary data were loaded correctly.

3. The X-Y coordinates of the dioxin sampling sites were read and loaded into the memory.

4. The dioxin sampling sites were displayed on the map of the EDA to provide a visual check of the site data.

5. An elliptical locally contaminated area was analytically placed on the map of the EDA by taking an ellipse with a centroid at the origin, rotating that ellipse a random number of degrees, and then translating the rotated ellipse to the EDA area a random number of feet up and a random number of feet over.

6. The locally contaminated area placed in step 5 was classified as to whether or not it fell totally within the EDA by using a 16-point representation of the ellipse and performing a check on the 16 points to determine if all 16 points lay within any of the 13 neighborhoods of the EDA. If all 16 points lay within one or more EDA neighborhoods, then the locally contaminated area was classified as being within the EDA.

7. If the locally contaminated area was classified as being within the EDA in step 6, then the dioxin sampling sites were checked to see if any sites lay within the locally contaminated area, then, if so, the locally contaminated area was classified as "sampled"; otherwise it was classified as "not sampled." Analytically, this was done by using the equation for an ellipse:

$$X^2/a^2 + Y^2/b^2 = 1, \text{ where} \qquad (1)$$

a = one-half of the length of the major axis
b = one-half of the length of the minor axis
X,Y = the ellipse border centered at the origin

Given values for X and Y, if the left-hand side of equation 1 was less than or equal to 1, then the X-Y point lies inside or on the border of the ellipse. The proper X-Y coordinate transformations were performed and applied to equation 1 to determine if a site was inside the locally contaminated area.

8. Steps 5 through 7 were repeated many times to get a good estimate of the probability of sampling a locally contaminated area.

At all steps in the development, graphical displays were used to verify that the procedures were correct. For instance, graphical displays of the randomly placed ellipses with the classification of that ellipse as "in" or "out" of the EDA were used to verify steps 5 and 6.

RESULTS

A simulation run of 10,000 randomly placed ellipses was used to estimate the probability that a locally contaminated area would have been sampled. The results of this run were:

Number of ellipses simulated = 10,000
Number of ellipses in the EDA = 4,144
Number of ellipses with sites = 3,634
Number of ellipses without sites = 510
Percentage of ellipses with sites = 88 (3,634/4,144)

The ratio of hits to misses is an empirical estimate of the probability of detecting a contaminated area. This 88 percent estimate could be biased slightly high because 14 of the 2,274 points sampled had no valid results; however, this estimate is biased low because the EDA contained areas of 6,500 square feet or larger that did not have accessible soil (i.e., the area was paved) but were not removed from the simulated EDA.

WDR356/053

APPENDIX U
Letter:
Summary of Preliminary Research on Sampling Point with Results above Level of Concern, March 31, 1988

Soil Assessment--2, 3, 7, 8-TCDD

Prepared by

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March 31, 1988

Doug Garbarini
USEPA - Region II
26 Federal Plaza
New York, New York 10278

RE: Vacant Lot with Dioxin

Dear Doug:

The following information has been uncovered regarding the lot where approximately 20 ppb 2378-TCDD was found in soil:

Lot number - 161.15-2-53 (called Lot C on CH2M Hill maps)

Lots in fenced area	LCARA purchased	House demolished	Previous owner
661 100th St	2/18/81	9/4/85	LeMaster
657 100th St	4/3/81	4/2/84	Starr
Lot C	owned by City of Niagara Falls		
645 100th St	12/1/80	9/4/85	Stevens

Lot C is located on the southern margin of a "swale". A soil core taken from the lot at 657 100th St. found "fill" to at least 3 feet in depth, and undisturbed soil was found at 6 feet. At 661 100th St. fill extended to at least 4 feet with undisturbed soil at 5 feet. Data for intervening depths was not available.

Sincerely,

Ed Horn

Edward G. Horn, Ph.D.
Environmental Scientist
Division of Environmental Health
Assessment

cc: J. Liddle
M. O'Toole
W. Stasiuk
T. VanEpp

APPENDIX V
Letter:
Results of Followup Investigation,
July 6, 1988

Soil Assessment--Indicator Chemicals

Prepared by

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July 6, 1988

Mr. Doug Garbarini
USEPA - Region II
26 Federal Plaza, Room 737
New York, NY 10278

RE: 2,3,7,8-TCDD Concentrations in Soil Samples Collected in the Vicinity of Lot C, 100th St., Love Canal EDA, Niagara Falls, NY

Dear Mr. Garbarini:

This letter report summarizes the results of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) analysis of soil samples collected by Ecology and Environment, Inc. (E & E), on April 11 and 12, 1988, in and around Lot C, 100th Street, Love Canal EDA, Niagara Falls, New York.

HISTORY

During 1986 and 1987, over 2,000 soil samples were collected in the Love Canal Emergency Declaration Area (EDA) to determine the concentrations of 2,3,7,8-TCDD as part of the Love Canal EDA Habitability Study. These results are summarized in Volume IV of the Love Canal EDA Habitability Study report (CH2M Hill, March 1988).

In the 1986-87 study, 2,3,7,8-TCDD was found at concentrations above the study target level of 1 part per billion (1 ppb) at only one sample location (Station 4256), located in Lot C, 100th Street, where only surface soil was sampled. In several analyses, the 2,3,7,8-TCDD was found at concentrations ranging from 17.3 to 21.2 ppb.

Based on these data, USEPA-Region II requested E & E to sample surface and subsurface soils in the vicinity of Station 4256 to determine the extent of dioxin contamination. The sampling strategy was developed by NUS Corporation, Superfund Division, and employed a radially stratified random sample design (NUS 1986).

E & E determined sampling locations and developed the soil sampling plan (E & E 1988). Surface (0 to 2 inches) and subsurface (2 to 7 inches, and 7 to 12 inches) samples were collected at 33 locations (see Figure 1). The surface sample was analyzed from all locations. Subsurface samples were analyzed from selected locations. One-hundred-sixty-six samples were collected, including 32 QA/QC samples. Sampling procedures, chain-of-custody procedures, documentation and the Health and Safety plan are presented in the soil sampling plan (E & E 1988) and the sampling letter report appended to this letter.

ANALYTICAL LABORATORIES

Thirty-five surface soil samples and eight QA/QC samples were shipped for analysis to Compuchem Laboratories, Research Triangle Park, NC, on April 12, 1988. Sixteen subsoil samples were sent for analysis to Environmental Testing Corporation on May 13, 1988. The results of these analyses are presented herein.

ANALYTICAL RESULTS

Surface soil analyses in the current study revealed 2,3,7,8-TCDD at only one location (Station 1033) at a concentration of 35.1 ppb. This location was within several feet of Station 4256 of the 1986-87 study.

Subsoil samples were also collected at Station 1033. Analyses for 2,3,7,8-TCDD revealed 32.7 ppb in the 2 to 7 inch interval (sample 1033-2) and 5.9 ppb in the 7 to 12 inch interval (sample 1033-4).

All analytical results are presented in Table 1. Horizontal and vertical coordinates shown were calculated relative to the center point (1033). Radial distances from the center point to each sample station are also shown.

Maximum possible concentrations are listed for samples which were below the analytical detection limit.

DISCUSSION

The compound 2,3,7,8-TCDD was found at only one location (Station 1033), in close proximity to Station 4256, the only location where 2,3,7,8-TCDD was found in the 1986-87 study. The surface soil concentration in the current study was the same range as was found in the 1986-87 study. Decreasing concentrations were found at progressively greater depths. No other detectable concentrations were found. No statistical data analysis is presented, since there is no evidence of any lateral concentration gradient at the site.

Sincerely,

Nancy J. Aungst
for Joseph T. Angley, Ph.D.

JTA/jf

Enclosure

L1

Table 1
SUMMARY OF ANALYTICAL RESULTS

E & E SAMPLE NO.	SECTOR	DEPTH INCHES	HORIZONTAL COORDINATE [1]	VERTICAL COORDINATE [2]	CONCENTRATION PPB	MPC [3]	RADIAL DISTANCE FROM CENTER (FT)
1988 DATA							
1033-1	CENTER POINT	0-2	0	0	35.10	- [5]	0
1033-3	CENTER POINT	2-7	0	0	32.7	-	0
1033-4	CENTER POINT	7-12	0	0	5.9	-	0
1001-1	A1	0-2	- 6.608	+ 0.772	ND [4]	0.46	6.65
1001-3	A1	2-7	- 6.608	+ 0.772	ND	0.13	6.65
1001-4	A1	7-12	- 6.608	+ 0.772	ND	0.12	6.65
1002-1	A2	0-2	- 9.305	+ 8.561	ND	0.13	12.64
1002-3	A2	2-7	- 9.305	+ 8.561	ND	0.20	12.64
1002-4	A2	7-12	- 9.305	+ 8.561	ND	0.13	12.64
1003-1	A3	0-2	- 5.332	+12.122	ND	0.87	13.24
1004-1	A4	0-2	+ 1.485	+ 2.896	ND	0.72	3.25
1004-3	A4	2-7	+ 1.485	+ 2.896	ND	0.17	3.25
1004-4	A4	7-12	+ 1.485	+ 2.896	ND	0.10	3.25
1005-1	A5	0-2	+10.343	+ 6.439	ND	0.43	12.18
1005-6	A5	0-2	+10.343	+ 6.439	REJECTED [6]		12.18
1006-1	A6	0-2	+ 4.216	+ 2.110	ND	0.77	4.71
1006-3	A6	2-7	+ 4.216	+ 2.110	ND	0.17	4.71
1006-4	A6	7-12	+ 4.216	+ 2.110	ND	0.080	4.71
1007-1	A7	0-2	+ 6.835	- 3.115	ND	0.72	7.51
1007-3	A7	2-7	+ 6.835	- 3.115	ND	0.16	7.51
1007-4	A7	7-12	+ 6.835	- 3.115	ND	0.12	7.51
1008	A8	0-2	+ 3.799	- 5.641	ND	0.52	6.8
1042-1	A9	0-2	+ 0.708	- 5.582	ND	0.49	5.63
1042-3	A9	2-7	+ 0.708	- 5.582	ND	0.17	5.63
1042-4	A9	7-12	+ 0.708	- 5.582	ND	0.12	5.63
1010	A10	0-2	- 5.387	-10.364	ND	0.27	11.68
1011-1	A11	0-2	-10.063	- 8.027	ND	0.20	12.87
1011-3	A11	2-7	-10.063	- 8.027	ND	0.11	12.87
1011-4	A11	7-12	-10.063	- 8.027	ND	0.23	12.87
1012	A12	0-2	- 8.885	- 2.198	ND	0.55	9.15
1013	B1	0-2	-15.450	+ 3.819	ND	0.40	15.92
1014	B2	0-2	-14.240	+ 9.490	ND	0.57	17.12
1015	B3	0-2	- 2.668	+17.965	ND	0.33	18.16
1016	B4	0-2	+ 8.966	+15.747	ND	0.62	18.12
1017	B5	0-2	+22.749	+15.753	ND	0.71	27.67

Table 1 (Cont.)

E & E SAMPLE NO.	SECTOR	DEPTH INCHES	HORIZONTAL[1] COORDINATE	VERTICAL[2] COORDINATE	CONCENTRATION PPB	MPC[3]	RADIAL DISTANCE FROM CENTER (FT)
1018-1	B6	0-2	+29.137	+ 5.814	ND	0.64	29.71
1019-1	B7	0-2	+15.422	- 8.674	ND	0.40	17.69
1031-1	B7	0-2	+ 8.505	-32.496	ND	0.33	33.59
1020-1	B8	0-2	+20.870	-14.824	ND	0.20	25.60
1021-1	B9	0-2	+ 9.640	-18.802	ND	0.35	21.13
1022-1	B10	0-2	- 5.067	-30.171	REJECTED		30.59
1023-1	B11	0-2	-13.592	-12.383	ND	0.40	18.39
1024-1	B12	0-2	-15.241	- 6.005	ND	0.40	16.38
1025-1	C1	0-2	- 1.333	+37.379	ND	0.66	37.40
1025-5	C1	0-2	- 1.333	+37.379	ND	0.26	37.40
1059-1	C2	0-2	+12.335	+31.986	ND	0.23	34.28
1027-1	C3	0-2	+52.630	+37.303	ND	0.65	64.51
1028-1	C4	0-2	+39.840	+ 3.610	ND	0.50	40.00
1029-1	C5	0-2	+26.611	- 5.580	ND	0.28	27.19
1030-1	C6	0-2	+48.016	-29.260	ND	0.74	56.23
1032-1	C8	0-2	-15.081	-32.806	ND	0.21	36.11
1986-1987 DATA							
1778	-	0-2	- 13.53	+ 55.51	ND		57.14
1779	-	0-2	-112.45	-154.22	ND		190.86
1780	-	0-2	+ 38.86	- 27.79	ND		47.77
3290	-	0-2	- 24.98	- 19.51	ND		31.70
4256	-	0-2	+ 2.56	+ 0.52	17.3-21.2		2.61

1. Values represent distance in feet from the center point, perpendicular to the datum line in Figure 1. Minus values indicate westward direction. Positive values indicate eastward direction.

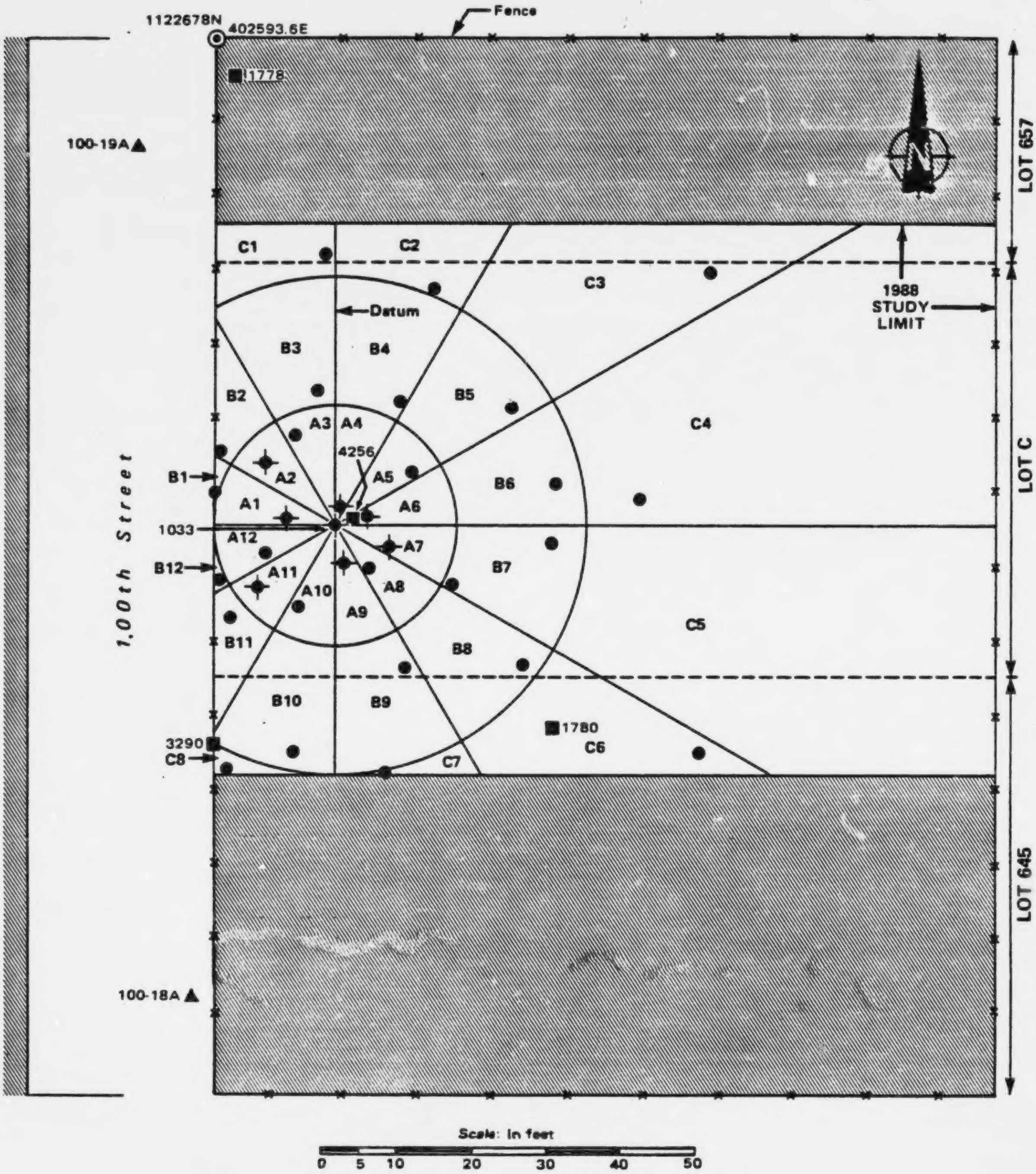
2. Values represent distance in feet from the center point, parallel to the datum line in Figure 1. Minus values indicate southward direction Positive values indicate northward direction.

3. MPC: maximum possible concentration.

4. ND: not detected.

5. - not applicable

6. Rejected: indicates data did not pass QA review by USEPA Region II Environmental Services Division.


1122678N
402593.6E
Fence
1778
100-19A
LOT 657
C1
C2
C3
1988 STUDY LIMIT
Datum
B3
B4
B2
B5
A3
A4
C4
4256
A5
B1
A2
B6
A1
A6
LOT C
1033
A12
A7
B12
A11
B7
A10
A8
A9
C5
B11
B8
B10
B9
1780
3290
C6
C8
C7
LOT 645
100-18A
1,00th Street
Scale: In feet
0
5
10
20
30
40
50

KEY:

◉ Coordinate Reference Point

■ 1986-1987 Sampling Station

● 1988 Sampling Station (Surface Soils Analyzed)

▲ Surveying Control Point

✦ 1988 Sampling Station (Surface and Subsurface Soils Analyzed)

Figure 1 ACTUAL DIOXIN SAMPLING POINTS, 100TH STREET, LOVE CANAL EDA, NIAGARA FALLS, NEW YORK

APPENDIX W

Memorandum:

Health Consultation Based on Results of the Soil Assessment for 2, 3, 7, 8-TCDD,

June 17, 1988

Prepared by

U.S. Department of Health & Human Services/
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service
Agency for Toxic Substances
and Disease Registry

Memorandum

Date June 17, 1988

From Toxicologist
Emergency Response Branch

Subject Health Consultation: Love Canal Emergency Declaration Area Habitability Study, Niagara Falls, New York

To Mr. William Q. Nelson
Public Health Advisor
EPA Region II
Through: Chief, Emergency Response Branch, OHA, ATSDR

Region II of the Environmental Protection Agency (EPA) asked the Agency for Toxic Substances and Disease Registry (ATSDR) to review the results of the Love Canal Emergency Declaration Area Habitability Study investigation of surface soil for dioxin contamination.

STATEMENT OF PROBLEM

Public concern for chemical contamination in the area around the Love Canal prompted the Federal Government to provide funds to purchase the houses from those who wished to sell. Criteria for habitability of this area have been developed. A portion of this criteria is an assessment of dioxin contamination of the area surface soil. The results of an extensive surface soil sampling investigation are the subject of the primary document reviewed.

DOCUMENTS REVIEWED

1. "Love Canal Emergency Declaration Area Habitability Study," Final Report, CH2MHill Southeast, Inc., Reston, Virgina, March 1988.
2. "Soil Sampling Plan for Love Canal EDA Station NO. 4256," Ecology and Environment, Inc., April 5, 1988.

DISCUSSION

Both the Centers for Disease Control (CDC) and the ATSDR participated in design of the dioxin sampling plan for the Emergency Declaration Area (EDA). We believe that the execution of the designed plan provided data sufficient to define the surface soil 2,3,7,8-TCDD contamination within the EDA.

In a 1984 paper, Kimbrough et. al., (J. Tox. & Envir. Health, 14: 47-93) stated that 1 ppb of 2,3,7,8-TCDD in soil is a reasonable level at which to begin consideration of action to limit human exposure for contaminated soil. The results from 2274 surface soil samples show that the general 2,3,7,8-TCDD contamination within the EDA is below the action level for surface soils. Chemical analysis showed positive 2,3,7,8-TCDD results below the action level for 48 samples. Of these only three sample locations had results greater than 0.5 ppb. These results show that 2,3,7,8-TCDD is not present in the surface soil of the EDA at a concentration of human health concern.

Only one sample had a 2,3,7,8-TCDD concentration exceeding the action level. The results for this sample ranged from 17.3 to 21.2 ppb. The location was directly across the street from the gate to the Love Canal dewatering facility. The positive results prompted analysis of additional aliquots of the sample in order to substantiate the results. In response to these results EPA installed a fence around the entire property associated with the sample location in order to restrict human access. They then had a contractor develop a point source sampling plan to determine the extent of contamination around this sample point. The results from this sampling are now undergoing quality assurance/quality control (QA/QC) evaluation. Preliminarily, the results from a repeat sample within 6 inches of the initial sample range from about 25 to 35 ppb (private communication from CDC's member on the Technical Review Committee). Areas based on concentric circles divided into 12 sectors each and centered on the initial sample location defined the sampling plan locations. Reportedly, results from randomly selected discrete sampling locations within each sector are in the range from nondetect to low tenths of a ppb. Of these, only those from 2 sectors are positive for 2,3,7,8-TCDD, slightly above the detection limits. Further evaluation of these results awaits the completion of the QA/QC evaluation.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of an extensive surface soil sampling for 2,3,7,8-TCDD within the EDA, it is the opinion of ATSDR:

1. That the investigation for 2,3,7,8-TCDD contamination is adequate to define the potential exposure of humans posed by that chemical's presence in the area.

2. That there is no evidence of widespread 2,3,7,8-TCDD contamination in the surface soil within the EDA which might present any threat to human health for the residents.

3. That the only soil requiring remediation because of the evidence of 2,3,7,8-TCDD prior to residential use is at sample location 4256.

Mark A. McClanahan, Ph.D

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